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LOCKHEED MARTIN

September 21, 2015

Ms. Piper Peterson
Superfund Project Manager
Office of Environmental Cleanup
Region 10, US Environmental Protection Agency
1200 Sixth Avenue, Suite 900 – M/S ECL-111
Seattle, WA 98101-3140

RE: REMEDIAL DESIGN WORK PLAN AND REQUEST FOR SCHEDULE APPROVAL, LOCKHEED WEST SEATTLE SUPERFUND SITE, SEATTLE, WASHINGTON

Dear Ms. Peterson:

Lockheed Martin is pleased to submit one (1) electronic copy of the Remedial Design Work Plan, Lockheed West Seattle Superfund site. A hard copy of the document will be provided if EPA requests a hard copy. The Work Plan addresses EPA's August 20, 2015 comments. A table summarizing our responses to comments is enclosed. This submittal meets Lockheed Martin's requirements under Section IV, Task A of the UAO Statement of Work, Appendix B to the Unilateral Administrative Order for Remedial Design and Remedial Action (U.S. Environmental Protection Agency [EPA] Docket No. CERCLA-10-2015-0079).

The schedule included in the Remedial Design Work Plan specifies initiation of field work on November11, 2015. This is 30 days after our assumed EPA approval date of October 11, 2015, consistent with the UAO requirement to initiate field work within 30 days of EPA approval of the Work Plan. EPA may approve the Remedial Design Work Plan earlier than October 11, 2015. If EPA approves the Work Plan sooner than October 11, we would like to request EPA approval for a fixed field work start date of November 11, 2015. This request is due to the complexities of planning for the field program including coordination of access with the Port of Seattle and logistics of having multiple subcontractors (drillers, barge, etc.) required to complete the field work.

Should you require anything further or have any questions please contact me at 720-842-6106.

Yours truly,

Bill Bath

Bill Bath
Project Coordinator
Environmental Remediation

Cc (electronic):

Alison O'Sullivan, Suquamish Tribe
Glen St. Amant, Muckleshoot Tribe
Erika Shaffer, WA Dept of Natural Resources
Brick Spangler, Port of Seattle
Jing Liu, Washington Department of Ecology
Marilyn Gauthier, CH2M Hill
Kristen Kerns, ACOE
Gene Matsushita, LMC
Mary Morningstar, LMC
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Dale Truskett, LMC
Gary Braun, Tetra Tech
Rick Osgood, Tetra Tech
Matt Schultz, CDM Smith
Darryl Armstrong, Armstrong Associates

BUR184 Remedial Design Work Plan

Remedial Design Work Plan
Lockheed West Seattle Superfund Site
Seattle, Washington

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

September 21, 2015

Revision 1

Gary Braun
Project Manager

REVISION TABLE					
Revision Number	**Prepared By**	**Submittal To**	**Submittal Dates**	**Change Description**	
				Section	**Narrative (of Items Affected)**
0	Tetra Tech, Inc.	EPA	7/20/2015	All	Draft
1	Tetra Tech, Inc.	EPA	9/21/2015	All	Final

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ACRONYMS

§	section
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
CPT	Cone Penetration Test
CQA	construction quality assurance
CQAP	construction quality assurance plan
CSL	cleanup screening level
DMMP	Dredged Material Management Program
DNR	Washington State Department of Natural Resources
DPM	Design Project Manager
Ecology	Washington Department of Ecology
ENR	enhanced natural recovery
EPA	U. S. Environmental Protection Agency
ESA	Endangered Species Act
ESD	Explanation of Significant Differences
FoS	Factor of Safety
FSP	field sampling plan
FVT	Field Vane Test
GPS	global positioning system
GSR	Green and Sustainable Remediation
HASP	health and safety plan
HPAH	heavy weight polycyclic aromatic hydrocarbons
ICIAP	Institutional Controls Implementation and Assurance Plan
kHz	kilohertz
LDW	Lower Duwamish Waterway
Lockheed Martin	Lockheed Martin Corporation
LTMMP	Long-Term Monitoring and Maintenance Plan
MHHW	mean higher high water
MLLW	mean lower low water

MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NMFS	National Marine Fisheries Service
OSWER	(U.S. EPA) Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PESM	Project Environmental and Safety Manager
PSR	Pacific Sound Resources
QAPP	Quality Assurance Project Plan
QC	quality control
RAO	Remedial Action Objective
RCW	Revised Code of Washington
RDWP	Remedial Design Work Plan
RI/FS	Remedial Investigation/Feasibility Study
RD/RA	Remedial Design/Remedial Action
ROD	Record of Decision
RPM	Remedial Project Manager
SSHO	Site Safety and Health Officer
Site	Lockheed West Seattle Superfund Site
SMS	sediment management standards
SOW	Statement of Work
SPT	Standard Penetration Test
SQS	sediment quality standards
SVOC	semivolatile organic compound
TI	technical impracticability
TOC	total organic carbon
U&A	Usual and Accustomed
UAO	Unilateral Administrative Order
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
WAC	Washington Administrative Code

Section 1
Introduction

This Remedial Design Work Plan (RDWP) was prepared as required by Section IV.A of the Statement of Work (SOW), Appendix B to the Unilateral Administrative Order (UAO) (U.S. Environmental Protection Agency [EPA] Docket No. 10-2015-0079/Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]) for the Remedial Design and Remedial Action for the Lockheed West Seattle Superfund Site (Site) (Figure 1-1). This RDWP has been prepared as part of the remedial design phase for implementation of the remedial action set forth in the Record of Decision (ROD) for the Lockheed West Seattle Superfund Site (EPA, 2013) and in the associated Explanation of Significant Differences (ESD) (EPA, 2015a).

This RDWP is submitted on behalf of the Lockheed Martin Corporation (Lockheed Martin). The remedial design process for the Site is based on a flexible and cooperative effort between EPA and Lockheed Martin. This effort aims to produce a cost-effective and timely remediation strategy. The UAO, the Statement of Work, the ROD and associated ESDs, and the EPA Superfund Remedial Design and Remedial Action Guidance (Office of Solid Waste and Emergency Response [OSWER] Directive 9355.0-4A) were followed to prepare and will be followed to implement the RDWP.

1.1 BACKGROUND

The Site was placed on the National Priorities List on March 7, 2007. Prior to this, the Site was listed as a sediment cleanup priority project under State of Washington authority through the requirements of the Model Toxics Control Act (MTCA). Lockheed Martin submitted the *Final Remedial Investigation/Feasibility Study for the Lockheed West Seattle Superfund Site* to EPA Region 10 in May 2012 (RI/FS) (Tetra Tech, 2012). The RI/FS concluded that sediments within the Site contained elevated levels of a number of hazardous contaminants. Analytical data from surface and subsurface sediment samples indicate that metals, polychlorinated biphenyls (PCBs), tributyltin, and polycyclic aromatic hydrocarbons (PAHs) are the most frequently detected compounds in the study area. Dioxins and furans also were identified as contaminants of concern (COCs) based on their assumed presence at the Site.

On August 28, 2013, EPA issued the ROD for the Site based on the area identified in the RI/FS that warranted remedial action. The ROD presented a Selected Remedy (Figure 1-2) to address unacceptable human health risks associated with seafood consumption, net fishing, clamming, and beach play, as well as ecological risks posed to benthic invertebrates, fish, and birds. The cleanup under this ROD represents the final remedial action for the Site.

In February 2015, EPA issued an ESD to correct errors in Tables 12 and 23 of the ROD that set forth Cleanup Levels and methods for demonstrating compliance for COCs. The ESD replaced the tables and described the differences between the ROD and the final details for COC Cleanup Levels.

On April 2, 2015, EPA issued the UAO for Remedial Design and Remedial Action, documenting Lockheed Martin’s responsibility for cleanup of the Site. The SOW, attached as Appendix B to the UAO, is the basis for the remedial design and remedial action activities for the Site. Lockheed Martin does not currently own, lease, or otherwise control any of this property, but is responsible to perform the work described in the UAO.

1.2 LOCKHEED WEST AREA

The Site is located near the confluence of the West Waterway and Elliott Bay, in Seattle, Washington (Figure 1-1). The Site is bordered by Elliott Bay on the north, the Harbor Island West Waterway Operable Unit on the east, Pacific Sound Resources Marine Sediment Unit on the west, and the Port of Seattle Terminal 5 to the south. The Site includes the in-water marine sediments where the former Lockheed Shipyard No.2 was located (the shipway and dry docks were located in the water over the sediments). The Site also includes a narrow shoreline bank defined as areas extending from plus [+] 11.3 feet mean higher high water (MHHW) to intertidal sediments (exposed by low tides) at minus [-] 10 feet mean lower low water (MLLW) along the northern and eastern shorelines, as well as subtidal sediments (never exposed by low tides) that extend to -40 to -50 feet MLLW in historically dredged areas. The Site is impacted by tides, with additional influence from the Lower Duwamish Waterway (LDW) that flows into the West Waterway. In addition, numerous pilings remain within the footprint of the former shipway and pier structures remain in the northwestern portion of the Site.

In total, the Site encompasses 40 acres of aquatic lands, including approximately 33 acres of state-owned aquatic lands managed by the Washington State Department of Natural Resources (DNR) and 7 acres of Port-owned aquatic tidelands. The Site is not currently used for Port-related or other commercial activities, but the Port reserves the right to develop along the north and west side of Terminal 5, including a potential multi-modal container terminal along the West Waterway as described in letters to the EPA in November 2010, May 2011, and September 2011. The Site and adjacent aquatic areas are designated as Tribal Usual and Accustomed (U&A) Fishing Areas. The bank and intertidal portions of the Site are accessible from the water. Access via land is currently restricted due to fencing around Terminal 5.

The Site is located in a historically industrialized and commercial area of Seattle. There are several nearby environmental cleanup projects and major drainage discharges in the vicinity (Figure 1-3). The primary land uses near the Site have been industrial and maritime for over a century. The adjoining area of the West Waterway includes a federally maintained navigation channel and numerous privately maintained berthing areas.

1.3 PURPOSE AND SCOPE

The purpose of this RDWP is to specify and describe all tasks required to conduct pre-design field investigative data collection and design the remedial action for the Site in accordance with the ROD, ESD, UAO, and the SOW. The major elements of the RDWP, as set forth in the SOW, include, but are not limited to:

- A description of all standards, criteria, and regulations applicable to the design of the remedy, and a discussion of how and when permit requirements (if any), access, land acquisition, and easement issues will be addressed (Section 2)
- A project schedule, including a timeline for completion of all design tasks and for submittal to EPA of interim and final deliverables enumerated in the SOW (Section 3)
- The responsibility and authority of all organizations and key personnel involved with the remedial design, including contractor personnel (Section 4)
- A background description of the Site and summary of existing data (Section 5)

- A detailed description of the pre-design investigation scope and rationale for why additional data is needed to support remedial design development (Section 6)
- A sampling and analysis plan for pre-remedial design activities (Section 7)
- A list and detailed description of individual design tasks, outlining the specific objectives and approach for each task necessary to meet the remedial design goals (Section 8)
- A project strategy for continuing community relations with affected parties through the phases of design and coordination with in-water work or navigation of other parties (Section 9)

1.4 WORK PLAN ORGANIZATION

The remainder of this document is organized into the following sections:

Section 2 – Remedy Standards and Requirements

Section 3 – Project Management and Schedule

Section 4 – Remedial Design Project Team

Section 5 – Site Background and Existing Data

Section 6 – Pre-Design Investigation Scope and Rationale

Section 7 – Field Sampling and Analysis Plan

Section 8 – Remedial Design Activities

Section 9 – Community Relations

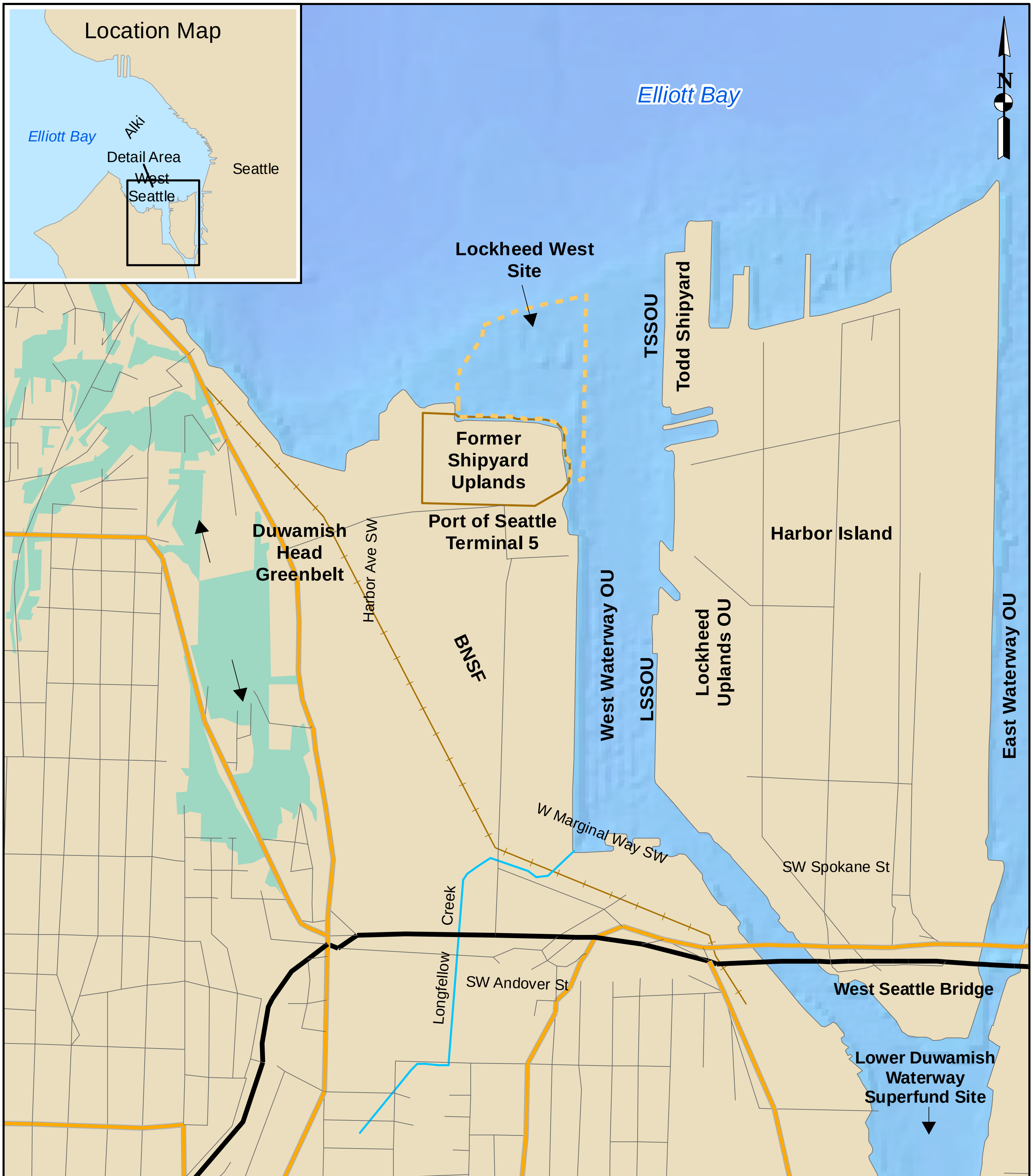
Section 10 – References

Tables and figures are included at the end of their respective sections. This document is also supported by the following appendices:

Appendix A – 2015 Field Reconnaissance Site Visit Photographs

Appendix B – Quality Assurance Project Plan (QAPP)

Appendix C– Health and Safety Plan (HASP)



Legend

	Site Boundary		Creek
	Highway		Railroad
	Major Road		Greenbelt
	Local Road	LSSOU	Lockheed Shipyard Sediment Operable Unit
	RA5 - Former Shipyard Uplands	TSSOU	Todd Shipyard Sediment Operable Unit
		OU	Operable Unit

Figure 1-1 Lockheed West Site Location and Vicinity Map

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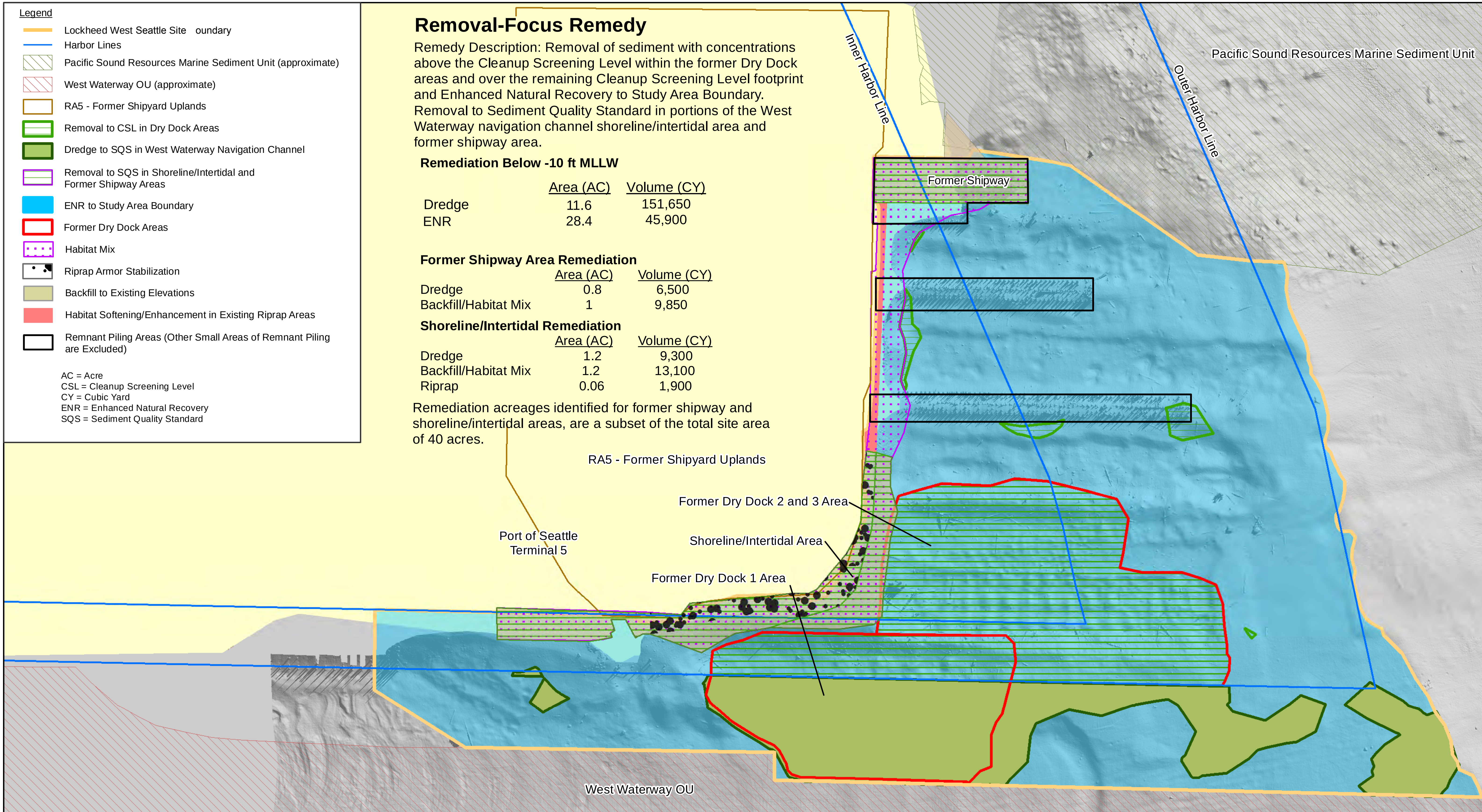

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0 125 250 500 Feet

Lockheed West Seattle Superfund Site Seattle, WA

Figure 1-2

EPA Selected Remedy
Lockheed West Seattle Superfund Site

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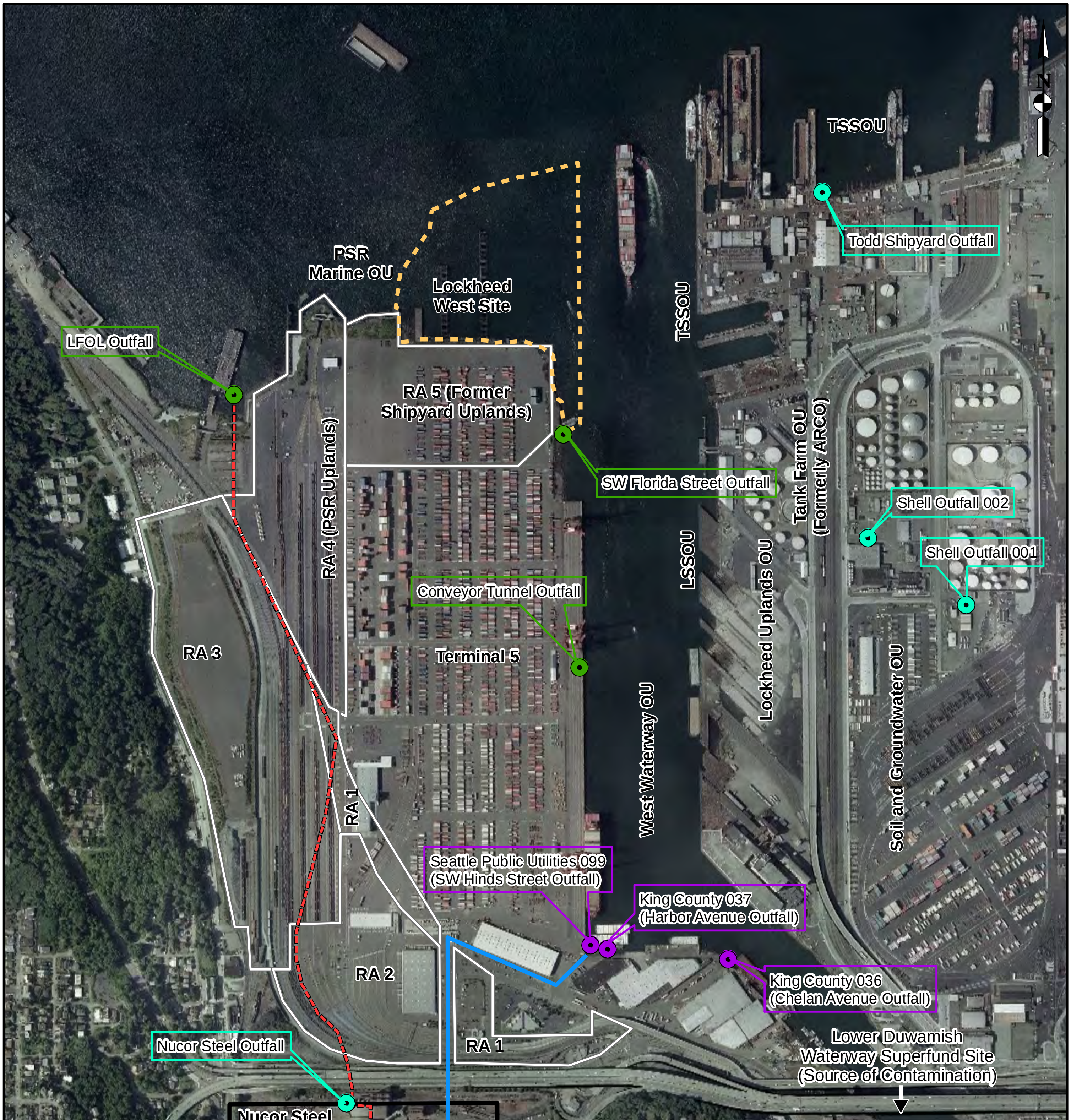

Legend

RA = Southwest Harbor Remediation Area
PSR = Pacific Sound Resources
LSSOU = Lockheed Shipyard Sediment OU
TSSOU = Todd Shipyard Sediment OU
NDPES = National Pollutant Discharge Elimination System
CSO = Combined Sewer Overflow
LFOL = Longfellow Overflow Line
OU = Operable Unit

Site Boundary
Remedial Action Areas
Longfellow Overflow Line
Longfellow Creek

Outfall Type

CSO
Other Drainage Feature
NDPES Permitted Discharge

Arial Imagery Source: United States Geological Survey 2002.

Figure 1-3 Nearby Environmental Cleanups and Major Discharge Features General Vicinity Map

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Section 2
Remedy Standards and Requirements

Implementation of the remedial design, as described in the Record of Decision (ROD), Explanation of Significant Differences (ESD), and Scope of Work (SOW), will be conducted in accordance with CERCLA (42 United States Code [U.S.C.] § 9601-96), as amended, and to the extent practicable, the National Contingency Plan and the Administrative Record for the Lockheed West Seattle Superfund Site (Site).

Section 121(d) of CERCLA requires selection of a remedial action that is protective of human health and the environment. EPA's approach to determining protectiveness involves risk assessment, considering applicable or relevant and appropriate requirements (ARARs), and to-be-considered criteria (TBC). This section presents a description of the cleanup objectives, a brief description of the ARARs identified in Section 2.10.4 of the ROD, as well as TBC for the Site. ARARs are derived from promulgated Federal standards, or more stringent promulgated state standards. The identification of ARARs was an iterative process and was considered complete with preparation of the ROD.

The ROD selected a combination of sediment remedial actions including dredging and disposal, backfill of intertidal removal areas, residuals management, thin cover/enhanced natural recovery (ENR) layer placement, removal of debris and pilings, institutional controls, and long-term monitoring and maintenance as the remedy for achieving the Site cleanup objectives. Source control activities in the upland Terminal 5 area were completed previously by others under a separate EPA Order with the Washington State Department of Ecology (Ecology) and are not part of the SOW. The UAO does not require additional source control activities or the prevention of releases of hazardous substances originating outside the boundaries of the Site and that are not attributable to Lockheed Martin (e.g., potential releases from nearby sources; Figure 1-3).

The Selected Remedy will meet the ARARs, as described further below. However, a technical impracticability (TI) waiver of the Federal ambient water quality criteria (AWQC) for arsenic is part of the Selected Remedy because it is technically impracticable for remediation of contaminated sediments at the Site to measurably improve the overall water quality for arsenic within the larger Elliott Bay. To the extent there is movement of contaminated water onto the Site, originating outside the boundaries of the Site and not attributable to Lockheed Martin, a TI waiver of the AWQC for other chemicals of concern may also be needed.

Following implementation of the Selected Remedy, the Site would be suitable for its current and anticipated future use, which includes a navigation channel. However, due to potential ongoing presence of other contaminant sources throughout Elliott Bay, the Site will not be suitable for unrestricted consumption of fish and will continue to be subject to the existing Elliott Bay-wide fish consumption advisory.

2.1 CLEANUP OBJECTIVES

The ROD defined the following Remedial Action Objectives (RAOs) to address the risks posed to human health and the environment:

- Human Health Risks:
    - **RAO 1 –** Reduce human health risks associated with the consumption of resident seafood by adults and children with the highest potential exposure.
    - **RAO 2 –** Prevent human health risks from direct exposure (skin contact and incidental ingestion) to contaminated sediments during netfishing, clamming, and beach play.
- Ecological Risks:
    - **RAO 3 –** Prevent risks to benthic invertebrates from exposure to contaminated sediments.
    - **RAO 4 –** Prevent risks to crabs, fish, and birds from exposure to contaminated sediments.

The ROD and associated ESD set Cleanup Levels for contaminants of concern (COCs). These levels represent Site-specific concentration limits to be achieved at the sediment surface (upper 10 centimeters [cm] in subtidal zone, upper 45 cm in intertidal zone) after dredging or excavation and placement of the dredge residual management/ENR layers or intertidal backfill and provide the basis for meeting the RAOs. The Cleanup Levels for demonstrating compliance are listed in Table 2-1.

The Cleanup Levels meet the RAOs in the following ways:

- Human Health Risks:
  - **RAO 1** is met when Site-wide average concentrations of COCs in the upper 45 cm of intertidal sediment and in the upper 10 cm of subtidal sediment do not exceed Cleanup Levels that are based on human consumption of seafood caught or gathered at the Site.
  - **RAO 2** is met when Site-wide average concentrations of COCs in the upper 45 cm of intertidal sediment and in the upper 10 cm of subtidal sediment do not exceed the Cleanup Levels that are based on direct contact with sediment during netfishing, Tribal clamming, or beach play.
- Ecological Risks:
  - **RAO 3** is met when point-by-point concentrations of COCs in the upper 10 cm of intertidal and subtidal sediments do not exceed Cleanup Levels that are based on protection of benthic invertebrates (Sediment Quality Standards [SQS][1] values).
  - **RAO 4** is met when Site-wide average concentrations of COCs in the upper 10 cm of intertidal and subtidal sediments do not exceed Cleanup Levels that are based on protection of crabs, fish, and birds.

In addition to the Cleanup Levels, numeric construction performance standards for the Site remedial action include the following:

- Construction Activity Limits – Defined limits on environmental impacts related to construction activities, including ambient water quality criteria (AWQC) and other ARARs to be defined in the construction quality assurance plan (CQAP) and associated documents.

- Remedial Action Levels – Contaminant concentrations to be achieved at the bottom of the dredge prism after dredging or excavation is complete and before placement of the dredge residual management layer or intertidal backfill. The Remedial Action Levels are based primarily on the SQS and cleanup screening levels (CSLs). The RAO 3 Cleanup levels will be achieved by remediating sediment above the SQS across the Site with removal of

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[1] ARARs were frozen at the time the ROD was signed (Aug 2013). Therefore, the revised (2014) Washington State Sediment Management Standards (SMS) terminology is not used at this site because it was not an ARAR at the time the ROD was signed. The CSL and SQS terminology will be used for all work related to the Site.

sediment in non-navigation areas to the CSL. The more stringent SQS values correspond to sediment quality that has no acute or chronic adverse effects on benthic marine organisms, the less stringent CSL values are levels above which minor adverse effects may occur in benthic marine organisms. The Remedial Action Levels and locations where they will be applied are listed in Table 2-2.

2.2 KEY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Remedial design sampling and analysis evaluations and remedial design construction drawings and specifications conducted under this SOW must provide sufficient data to ensure that the requirements of several different regulatory programs are met. As identified in the ROD, the requirements of the key programs in relation to remedial action for the Site are as follows:

- Washington State Model Toxics Control Act (MTCA) (Revised Code of Washington [RCW] 70.105D; Washington Administrative Code [WAC] 173-340): MTCA is applicable or relevant where the substantive requirements are more stringent than CERCLA and the National Contingency Plan (NCP). The more stringent requirements of MCTA include, but are not limited to, acceptable excess cancer risk standards and the default to natural background for final remedies where risk-based threshold concentrations are below background.
- Sediment Management Standards (WAC 173-204): The SMS are a statutory requirement under MTCA and applicable or relevant and appropriate under CERCLA. The SMS set numerical standards for the protection of benthic marine invertebrates. The Selected Remedy will meet requirements of the SMS. SQS of the SMS are the standard for protection of benthic invertebrates.
- Clean Water Act, Section 304(a) (40 Code of Federal Regulations [CFR] 131): Federally recommended Water Quality Criteria that are more stringent than state criteria and that are relevant and appropriate apply to the Site. As noted above, the Selected Remedy includes a TI waiver for the AWQC for arsenic.
- Endangered Species Act of 1973 (50 CFR 17, 222-224, 226.212 to 402): To protect threatened species under the ESA, including Puget Sound Chinook salmon, environmental windows (or “fish windows”) have been established for Elliott Bay. These are designated periods, generally from October through February, when effects of in-water construction are minimized, largely because juvenile salmon are not migrating through the area. As part of remedial action implementation, EPA will consult with the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) to obtain a Biological Opinion. Habitat mitigation will be assessed and addressed in the remedial design, if necessary.

2.3 OTHER ARARS

Other ARARs identified in the ROD may impose requirements on the remedial design in addition to those established by the key ARARs discussed above:

- **Washington Water Pollution Control Act – State Water Quality Standards for Surface Water (RCW 90.48; WAC 173-303):** State surface water quality standards are applicable where the state has adopted, and EPA has approved, Water Quality Standards (Aquatic Life Criteria).

- **Resource Conservation and Recovery Act (40 CFR 260-279), Toxic Substances Control Act (40 CFR 761.61), and Washington State Dangerous Waste Regulations (RCW 70.105; WAC 173-303):** Federal and state hazardous waste management regulations, respectively. No known listed or characteristic hazardous wastes are present at the Site. However, if such wastes are encountered during Site cleanup, portions of the Resource Conservation and Recovery Act and Washington State Dangerous Waste Regulations related to hazardous waste determination and analytical testing, and onsite storage, treatment, and disposal may be ARARs to this project. State dangerous waste is defined more broadly than Federal hazardous waste. In addition, no known Toxic Substances Control Act wastes are present at the Site. If such wastes are encountered during Site cleanup, disposal of PCBs may be applicable.

- **Solid Waste Disposal Act (40 CFR 257-258) and Solid Waste Handling Standards (RCW 70.95; WAC 173-350):** Federal and state regulations that cover nonhazardous waste generated during remedial activities, unless wastes meet recycling exemptions.

- **Clean Water Act (40 CFR 121.2, 230, 231; 33 CFR 320, 322, 323), Rivers and Harbor Appropriations Act (33 U.S.C. 403), and Hydraulic Code Rules (RCW 77.65; WAC 220-110):** Federal and state requirements for in-water dredging, filling, and other in-water construction.

- **Marine Protection, Research, and Sanctuaries Act (33 U.S.C. 1401-1445) and Dredged Materials Management Program (RCW 79.105.500; WAC 332-30-166(3)):** Federal and state regulations for dumping of dredged material in open water.

- **National Pollutant Discharge Elimination System (40 CFR 122, 125) and Discharge Permit Program (RCW 90.48; WAC 173-216, 220, 226):** Federal and state point source standards for new discharges to surface water. Remediation discharges must comply with the substantive requirements of NPDES rules. If upland handling of sediment is planned, construction stormwater requirements will be addressed, including development of a stormwater pollution prevention plan and implementation of best management practices. NPDES program and state permitting requirements will be reviewed as part of project final design.

- **Coastal Zone Management Act (16 U.S.C. 1451 *et seq*) and Shoreline Management Act (WAC 173-16):** These Federal and state regulations are applicable to construction activities within 200 feet of the shoreline.

- **Clean Water Act Section 404(b)(1), Migratory Bird Treaty Act (16 U.S.C. 703-712; 50 CFR 10, 17), Eagle Protection Act (50 CFR 22); and City of Seattle Master Plan Seattle Municipal Code 23.60:** In addition to the ESA, these Federal and local laws address the conservation of endangered or threatened species. As noted above, habitat mitigation will be assessed and addressed in the remedial design as necessary. EPA will consult with the appropriate agencies to obtain Biological Opinions.

Table 2-1
Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)
Total PCBs	Yes	µg/kg dw	Subtidal	2 (nat. bkgd)	n/a	n/a	100 (RBTC – fish)
			Intertidal	2 (nat. bkgd)	n/a	n/a	n/a
			Point	n/a	n/a	12 mg/kg-OC/ 180 (SQS)	n/a
cPAHs	Yes	µg TEQ/kg dw	Subtidal	9 (nat. bkgd)	550 (RBTC)[6]	n/a	n/a
			Intertidal	9 (nat. bkgd)	15 (RBTC)[7]	n/a	n/a
			Point	n/a	n/a	n/a	n/a
Arsenic	Yes	mg/kg dw	Subtidal	7 (nat. bkgd)	7 (nat. bkgd)	n/a	n/a
			Intertidal	7 (nat. bkgd)	7 (nat. bkgd)	n/a	n/a
			Point	n/a	n/a	57 (SQS)	n/a
Lead	Yes	mg/kg dw	Subtidal	11 (nat. bkgd)	n/a	n/a	n/a
			Intertidal	11 (nat. bkgd)	n/a	n/a	50 (RBTC – sandpiper)
			Point	n/a	n/a	n/a	n/a
Tributylin	Yes	µg/kg dw	Subtidal	430 (RBTC – child)	n/a	n/a	150
			Intertidal	2,000 (RBTC – child)[8]	n/a	n/a	n/a
			Point	n/a	n/a	n/a	n/a
Copper	Yes	mg/kg dw	Subtidal	400 (RBTC – child)	n/a	n/a	114 (RBTC – fish)
			Intertidal	400 (RBTC – child)[8]	n/a	n/a	420 (RBTC – sandpiper)
			Point	n/a	n/a	390 (SQS/CSL)	n/a
Mercury	Yes	mg/kg dw	Subtidal	0.41 (RBTC – child)	n/a	n/a	n/a
			Intertidal	0.17 (RBTC – child)	n/a	n/a	n/a
			Point	n/a	n/a	0.41 (SQS)	n/a
Dioxins/Furans	Yes	ng TEQ/kg dw	Subtidal	2 (nat. bkgd)	37 (RBTC)[8]	n/a	n/a
			Intertidal	2 (nat. bkgd)	13 (RBTC)[8]	n/a	n/a
			Point	n/a	n/a	n/a	n/a

Table 2-1
Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)
Antimony	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	150 (LAET/SL)	n/a
Cadmium	No	mg/kg dw	Subtidal	0.398 (nat. bkgd)	n/a	n/a	n/a
			Intertidal	0.398 (nat. bkgd)	n/a	n/a	n/a
			Point	n/a	n/a	n/a	n/a
Chromium	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	260 (SQS)	n/a
Cobalt	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	10 (LAET/SL)	n/a
Nickel	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	140 (LAET/SL)	n/a
Selenium	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	1 (LAET/SL)	n/a
Vanadium	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	57 (LAET/SL)	n/a
Zinc	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	410 (SQS)	n/a
Pentachloro-phenol	No	µg/kg dw	Subtidal			n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	360 (SQS)	n/a
Bis(2-ethylhexyl)-phthalate	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	47 mg/kg-OC/ 710 (SQS)	n/a
Acenaphthene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	16 mg/kg-OC/ 240 (SQS)	n/a
Benzo(a)-anthracene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	110 mg/kg-OC/ 1,700 (SQS)	n/a
Benzo(a)pyrene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	99 mg/kg-OC/ 1,500 (SQS)	n/a
Benzo(g,h,i)-perylene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a

Table 2-1
Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)
			Point	n/a	n/a	31 mg/kg-OC/ 470 (SQS)	n/a
Total Benzofluor-anthenes	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	230 mg/kg-OC/ 1,800 (SQS)	n/a
Chrysene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	110 mg/kg-OC/ 1,700 (SQS)	n/a
Dibenz(a,h)-anthracene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	12 mg/kg-OC/ 180 (SQS)	n/a
Fluoranthene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	160 mg/kg-OC/ 2,400 (SQS)	n/a
Indeno(1,2,3-cd)pyrene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	34 mg/kg-OC/ 510 (SQS)	n/a
Phenanthrene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	100 mg/kg-OC/ 1,500 (SQS)	n/a
Total HPAH	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	960 mg/kg-OC/ 14,400 (SQS)	n/a

Table 2-1
Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)

[1] Unless noted differently in RAO-specific values
[2] The spatial scale of exposure is measured as site-wide (i.e., all subtidal and intertidal sediments), intertidal sediments only, and point measurements at single locations throughout the site (i.e., all subtidal and intertidal sediment locations) or at single locations in intertidal sediment only. The spatial scale is RAO-specific, with site-wide exposures applicable to human seafood consumption, human direct contact, and exposures of fish and crab. Intertidal-only exposures are applicable to human consumption of clams from intertidal areas and exposures of sandpiper. Point exposures are applicable to benthic organisms, which are evaluated at single station locations. The statistical metric for site-wide and intertidal evaluation of alternatives and compliance monitoring is the upper confidence limit on the mean, whereas point exposures are evaluated with concentration data at single locations.
[3] Cleanup levels are based on 10^{-6} cancer risk for carcinogens (e.g., PCBs, cPAHs, arsenic) or on a child exposure hazard quotient of 1 for noncarcinogens (lead, tributyltin, copper). Where Cleanup Levels are based on carcinogenic risks below background, the background concentration is selected; where no background values are available (chlordanes and DDT), the method detection limit (MDL) is selected.
[4] Applicable on a point exposure only. Values for PCBs and PAHs (except total benzofluoranthenes) are the organic carbon-normalized SQS and the dry weight equivalent based on an average sediment TOC content of 1.5%; for all other compounds values are dry weight. Under the SMS, sediment cleanup standards are established on a site-specific basis within an allowable range. The SQS and CSL define this range. For chemicals without SMS, LAET and 2LAET values or the SL and ML of the DMMP define this range.
[5] Cleanup levels for site-wide exposure are the lowest for either fish or crab; Cleanup levels for intertidal exposure are for sandpiper.
[6] The cleanup level for site-wide direct contact is based on netfishing.
[7] The cleanup level for intertidal direct contact is based on the lowest for either Tribal clamming or child beach play exposures.
[8] The cleanup for intertidal seafood consumption is based on consumption of clams from the intertidal sediment.

Notes:
µg/kg dw = micrograms per kilogram dry weight
µg TEQ/kg dw = micrograms Toxicity Equivalents per kilogram dry weight
COC = contaminant of concern
cm = centimeter(s)
cPAH = carcinogenic polycyclic aromatic hydrocarbon
CSL = cleanup screening level
DMMP = dredge material management program
dw = dry weight
HPAH = heavy weight polycyclic aromatic hydrocarbon
LAET = lowest apparent affect threshold
ML – maximum level
mg/kg-dw = milligrams per kilogram dry weight
n/a = compounds do not present a risk for the RAO scenario
Nat Bkgd = natural background
ng TEQ/kg-dw = nanograms toxicity equivalents per kilogram dry weight
OC = organic carbon (1.5%)
PCB = polycholorinated biphenyl
RAO = remedial action objective
RBTC = risk-based threshold concentrations
SL = screening level
SMS = Sediment Management Standards
SQS = sediment quality standards

Table 2-2
Remedial Action Levels to be Achieved at Sediment Surface Following Excavation and Dredging

COC	Risk Driver?	Compliance Zone[1]	RAL	Units	Source
Total PCBs	Yes	0 to 10 cm	12	mg/kg-OC	SQS
			180	µg/kg dw	
cPAHs	Yes	Not applicable			
Arsenic	Yes	0 to 10 cm	57	mg/kg-dw	SOS
Lead	Yes	0 to 10 cm	530	mg/kg-dw	CSL
Tributyltin	Yes	Not applicable			
Copper	Yes	0 to 10 cm	390	mg/kg-dw	SQS and CSL
Mercury	Yes	0 to 10 cm	0.41	mg/kg-dw	SOS
Dioxins/Furans	Yes	Not applicable			
Chromium	No	0 to 10 cm	260	mg/kg-dw	SQS
Cobalt	No	0 to 10 cm	10	mg/kg-dw	LAET/SL
Nickel	No	0 to 10 cm	140	mg/kg-dw	LAET/SL
Selenium	No	0 to 10 cm	1.	mg/kg-dw	LAET/SL
Vanadium	No	0 to 10 cm	57	mg/kg-dw	LAET/SL
Zinc	No	0 to 10 cm	410	mg/kg-dw	SQS
Pentachlorophenol	No	0 to 10 cm	360	mg/kg-dw	SQS
Bis(2-ethylhexyl)-phthalate	No	0 to 10 cm	47	mg/kg-OC	SQS
			710	µg/kg dw	
Acenaphthene	No	0 to 10 cm	16	mg/kg-OC	SQS
			240	µg/kg dw	
Benzo{a)anthracene	No	0 to 10 cm	110	mg/kg-OC	SQ5
			1,700	µg/kg dw	
Benzo(a)pyrene	No	0 to 10 cm	99	mg/kg-OC	SQS
			1,500	µg/kg dw	
Benzo(g,h,i)perylene	No	0 to 10 cm	31	mg/kg-OC	SQS
			470	µg/kg dw	
Total Benzofluoranthenes	No	0 to 10 cm	1,800	µg/kg dw	SQS
Chrysene	No	0 to 10 cm	110	mg/kg-OC	SQS
			1,700	µg/kg dw	
Dibenz(a,h)anthracene	No	0 to 10 cm	12	mg/kg-OC	SQS
			180	µg/kg dw	

Table 2-2
Remedial Action Levels to be Achieved at Sediment Surface Following Excavation and Dredging

COC	Risk Driver?	Compliance Zone[1]	RAL	Units	Source
Fluoranthene	No	0 to 10 cm	160	mg/kg-OC	SQS
			2,400	µg/kg dw	
Indeno(1,2,3-cd)pyrene	No	0 to 10 cm	34	mg/kg-OC	SQS
			510	µg/kg dw	
Phenanthrene	No	0 to 10 cm	100	mg/kg-OC	SQS
			1,500	µg/kg dw	
Total HPAH	No	0 to 10 cm	960	mg/kg-OC	SQS
			14,000	µg/kg dw	
Remedial Action Levels for Dry Docks (Area 4) and Localized Subareas (Area 5)					
Total PCBs	Yes	0 to 10 cm	65	mg/kg-OC	CSL
			960	µg/kg dw	
cPAHs	Yes	Not applicable			
Arsenic	Yes	0 to 10 cm	93	mg/kg-dw	CSL
Lead	Yes	0 to 10 cm	530	mg/kg-dw	CSL
Tributyltin	Yes	Not applicable			
Copper	Yes	0 to 10 cm	390	mg/kg-dw	SQS and CSL
Mercury	Yes	0 to 10 cm	0.59	mg/kg-dw	CSL
Dioxins/Furans	Yes	Not applicable			
Chromium	No	0 to 10 cm	270	mg/kg-dw	CSL
Cobalt	No	0 to 10 cm	n/a	mg/kg-dw	
Nickel	No	0 to 10 cm	n/a	mg/kg-dw	
Selenium	No	0 to 10 cm	n/a	mg/kg-dw	
Vanadium	No	0 to 10 cm	n/a	mg/kg-dw	
Zinc	No	0 to 10 cm	960	mg/kg-dw	CSL
Pentachlorophenol	No	0 to 10 cm	690	mg/kg-dw	CSL
Bis(2-ethylhexyl)-phthalate	No	0 to 10 cm	78	mg/kg-OC	CSL
			1,200	µg/kg dw	
Acenaphthene	No	0 to 10 cm	57	mg/kg-OC	CSL
			860	µg/kg dw	
Benzo(a)anthracene	No	0 to 10 cm	270	mg/kg-OC	CSL
			4,100	ug,/kg-dw	

Table 2-2
Remedial Action Levels to be Achieved at Sediment Surface Following Excavation and Dredging

COC	Risk Driver?	Compliance Zone[1]	RAL	Units	Source
Benzo(a)pyrene	No	0 to 10 cm	210	mg/kg-OC	CSL
			3,200	µg/kg dw	
Benzo(g,h,i)perylene	No	0 to 10 cm	78	mg/kg-OC	CSL
			1,200	µg/kg dw	
Total Benzofluoranthenes	No	0 to 10 cm	450	mg/kg-OC	CSL
			6,800	µg/kg dw	
Chrysene	No	0 to 10 cm	460	mg/kg-OC	CSL
			6,900	µg/kg dw	
Dibenz(a,h)anthracene	No	0 to 10 cm	33	mg/kg-OC	CSL
			500	µg/kg dw	
Fluoranthene	No	0 to 10 cm	1,200	mg/kg-OC	CSL
			18,000	µg/kg dw	
incleno(1,2,3-cd)pyrene	No	0 to 10 cm	88	mg/kg-OC	CSL
			1,300	µg/kg dw	
Phenanthrene	No	0 to 10 cm	480	mg/kg-OC	CSL
			7,200	µg/kg dw	
Total HPAH	No	0 to 10 cm	5,300	mg/kg-OC	CSL
			79,500	µg/kg dw	

[1] The Compliance Basis is Subtidal Surface Sediment (point), and is the same for all COCs.

Notes:
µg/kg dw = micrograms per kilogram dry weight
µg TEQ/kg dw = micrograms Toxicity Equivalents per kilogram dry weight
COC = contaminant of concern
cm = centimeter(s)
cPAH = carcinogenic polycyclic aromatic hydrocarbon
CSL = cleanup screening level
dw = dry weight
HPAH = heavy weight polycyclic aromatic hydrocarbon
LAET = lowest apparent affect threshold
mg/kg-dw = milligrams per kilogram dry weight
n/a = compounds do not present a risk for the RAO scenario
ng TEQ/kg-dw = nanograms toxicity equivalents per kilogram dry weight
OC = organic carbon (1.5%)
PCB = polycholorinated biphenyl
RAL = remedial action level
SL = screening level
SQS = sediment quality standards

Section 3
Project Management and Schedule

This section describes the overall remedial design process set forth in the Unilateral Administrative Order (UAO) and Scope of Work (SOW). The remedial design process for the Lockheed West Seattle Superfund Site (Site) is intended to produce a cost-effective and timely remediation strategy.

The remedial design process includes those activities necessary to prepare for implementation of the selected remedy and includes both pre-design and design activities. Pre-design activities are any activities necessary to develop sufficient information to support design of the selected remedy. Design activities are those activities necessary to prepare for implementation of the selected remedy. The steps of the remedial design process are:

- Review of existing data and identification of data gaps
- Pre-design investigative sampling, analysis, and data evaluation
- Establishment of design objectives and basis of design
- EPA review and approval
- Development of plans and specifications for the remedial action

Lockheed Martin's approach for project coordination, list of deliverables, and the project schedule to best accomplish the remedial design is described in this section.

3.1 SUMMARY OF REMEDIAL DESIGN STRATEGY

Lockheed Martin is seeking to achieve a cost-effective cleanup of the Site that is protective of human health and the environment, is consistent with the National Contingency Plan (NCP), and complies with the Record of Decision (ROD), Explanation of Significant Difference (ESD), UAO, and SOW.

The existing data for the Site includes the results from a series of studies conducted by Lockheed Martin and the Port of Seattle starting in 1984, as well as more recent data collected for the Site

RI/FS (Tetra Tech 2008; Tetra Tech 2012). Data from these efforts, when applicable, will be used to support the remedial design process for the Site. Data from pre-remedial design investigations conducted specifically to support remedial design for the Site will be used to supplement the existing data.

Remedial design documents will be prepared and submitted as preliminary (30 percent), intermediate (60 percent, if appropriate), pre-final (90 percent) and final (100 percent) design. Lockheed Martin's contracting strategy includes developing the design to the 30% level and then soliciting a design/build procurement where the successful bidder would complete the development of the design and then implement the remedial action. However, Lockheed Martin reserves the right to implement the selected remedy as a single combined design/construction contract or as separate design and construction contracts.

Design documents include, but are not limited to: design analyses; construction drawings and specifications for the Selected Remedy; construction quality assurance plan (CQAP); water quality monitoring plan; quality assurance project plans (QAPPs); field sampling plans (FSPs); health and safety plans (HASPs), long-term monitoring and maintenance plan (LTMMP); schedule; and cost estimate. These documents are described in Section 8.

3.2 COORDINATION

3.2.1 Progress Reports

Lockheed Martin will submit monthly progress reports to the EPA and the State and Tribes by the 10th of the month for the preceding reporting period. If this day is a weekend or holiday, progress reports will be submitted on the next business day. Progress reports will, at a minimum, contain the following information regarding the preceding month:

- Description of actions taken to comply with the UAO during the previous period
- Summary of all results of sampling and tests and all other data generated or received by Lockheed Martin or its contractors
- Plans, reports, and other deliverables required by the UAO completed and submitted
- Actions scheduled for the next six weeks and information regarding progress of construction (e.g., critical path diagrams, Gantt charts and Pert charts)
- Percentage completion, delays encountered or anticipated, and efforts to mitigate delays

- Modifications to work plans or other schedules that are proposed to EPA or have been approved by EPA
- Activities from the previous month and planned for the next six weeks in support of the Community Involvement Plan

3.2.2 Meetings

To ensure that planning and design for the remediation are undertaken in a manner that is cost-effective and timely, Lockheed Martin will hold monthly meetings with EPA, the Tribes, and other stakeholders (i.e., Washington State Department of Ecology, Washington State Department of Natural Resources [DNR], Suquamish and Muckleshoot Tribes, and Port of Seattle) to review progress, answer questions, and preview next steps. Other meetings related to design development will be scheduled on an as-needed basis.

3.3 DELIVERABLES

This Remedial Design Work Plan (RDWP) documents project tasks and management strategies necessary to adhere to deliverable schedules and complete the remedial design process. The quality of all reports and submittals to EPA will be ensured by strict adherence to the Tetra Tech Quality Assurance Program as it applies to activities and services performed by the corporation pertaining to consulting, engineering, and remediation services, including, but not limited to, internal technical and editorial review, independent verification of all calculations used in the design, the documentation of all reviews, and the process to be used to identify and correct problems. This program follows the guidance and applicable requirements of the American National Standards Institute (ANSI) / ISO / American Society for Quality (ASQ) Q9001-2008, Quality Management System Requirements Standard and ANSI/ASQ E4- 2004, Quality Management Systems for Environmental Data and Technology Programs. Tetra Tech procedures and criteria applicable include, but are not limited to:

- Tetra Tech Quality Practices Manual Rev 1
- SCI-1 Technical Review of Scientific Work Products
- ENG-1 General Procedure for Engineering Activities
- ENG-2 Developing, Issuing and Revising Engineering Design Documents

A full listing of Tetra Tech procedures will be provided to EPA upon request.

Lockheed Martin will prepare remedial design reports and plans for the implementation of the Selected Remedy, including:

- Pre-Remedial Design Data Report
- Design analysis (Basis for Design Report)
- Preliminary, Intermediate (if needed), Pre-Final, and Final Construction Drawings and Specifications
- Draft and Final Capital and Operation and Maintenance Cost Estimate
- Construction Project Schedule
- Draft CQAP
- Draft Water Quality Monitoring Plan (with specific QAPP/FSP)
- Draft QAPP/HASP/FSP for remedial action construction activities
- Draft Permitting and Site Access Plan
- Draft Site Management Plan
- Draft Long-term Monitoring and Maintenance Plan (LTMMP)
- Draft Biological Assessment
- Draft Institutional Control Implementation and Assurance Plan (ICIAP)

Lockheed Martin reserves the right to implement the selected remedy as a single combined design/construction contract or as separate design and construction contracts.

3.4 SCHEDULE

The schedule for the completion of the remedial design tasks for the Site, following the timeframes detailed in Section V of the SOW, is presented in Figure 3-1. The schedule is based on the April 13, 2015 effective date of the UAO. The schedule is also based on Lockheed Martin's planned contracting strategy of implementing the selected remedy as described in Section 3.3. If that strategy changes, a revised schedule will be developed. Draft deliverable due dates to EPA are listed in the SOW. Revised deliverables are due 30 days from the receipt of EPA comments, unless otherwise indicated by EPA. Documents become final upon written approval by EPA, which will be delivered by U.S. mail. Days are calendar days; if due dates fall on a weekend or holiday, deliverables will be submitted to EPA on the next business day. Where the deliverable date is triggered by notification, comments, or approval, the starting date for the period shown is the date Lockheed Martin received notification, comments, or approval (by mail or electronic mail), unless otherwise noted. For non-final RD and RA documents, the EPA may submit redlined files with embedded comments electronically with an email cover letter. Where triggered by EPA receipt of a deliverable, the starting date for the period shown is based on the date of the EPA signature on the delivery form or the mail receipt date. The schedule addresses the detailed design tasks and also lists some of the tasks associated with the remedial action for completeness. This schedule is limited to the design portion of the SOW and is not intended to commit Lockheed Martin to tasks that are associated with the remedial actions.

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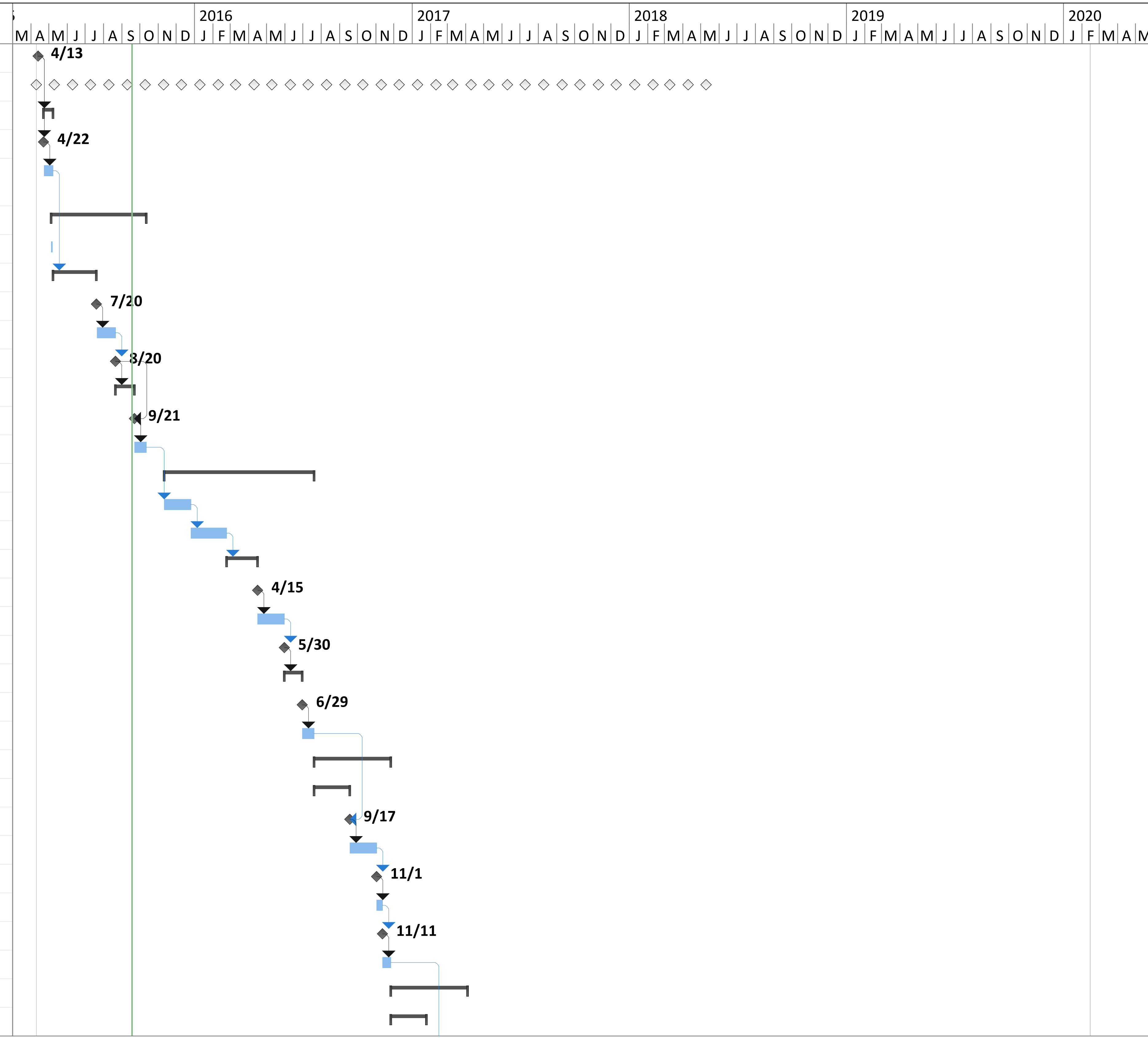
Figure 3-1 Lockheed West Seattle Project Schedule

ID	Task Name	Duration	Start	Finish
1	Unilateral Administrative Order Effective Date	0 days	Mon 4/13/15	Mon 4/13/15
2	Progress Reports	1126 days	Fri 4/10/15	Thu 5/10/18
41	Task 1 – Submittal of Quality Management Plan (QMP)	16 days	Wed 4/22/15	Thu 5/7/15
42	Submittal to EPA - QMP	0 days	Wed 4/22/15	Wed 4/22/15
43	EPA Review and Approval of Supervising Contractor; Notice to Proceed	15 days	Thu 4/23/15	Thu 5/7/15
44	Task 2 – Remedial Design Work Plan (RDWP)	160 days	Tue 5/5/15	Sun 10/11/15
45	Site Visit/Strategy Meeting	2 days	Tue 5/5/15	Wed 5/6/15
46	Prepare Remedial Design Work Plan (Draft)	73 days	Fri 5/8/15	Sun 7/19/15
50	Submittal of RDWP (Draft) to EPA	0 days	Mon 7/20/15	Mon 7/20/15
51	EPA Review of RDWP (Draft)	31 days	Tue 7/21/15	Thu 8/20/15
52	Receive EPA Comments - RDWP (Draft)	0 days	Thu 8/20/15	Thu 8/20/15
53	Revise RDWP (Final)	32 days	Fri 8/21/15	Mon 9/21/15
57	Submittal of RDWP (Final)	0 days	Mon 9/21/15	Mon 9/21/15
58	EPA Review and Approval of RDWP (Final)	20 days	Tue 9/22/15	Sun 10/11/15
59	Task 3 – Pre-Remedial Design Field Work	252 days	Wed 11/11/15	Tue 7/19/16
60	Field Work	45 days	Wed 11/11/15	Fri 12/25/15
61	Laboratory Analysis and Data Validation	60 days	Sat 12/26/15	Tue 2/23/16
62	Pre-Remedial Design Field Sampling (FS) Data Report (Dr	52 days	Wed 2/24/16	Fri 4/15/16
66	Submittal of FS Data Report (Draft) to EPA	0 days	Fri 4/15/16	Fri 4/15/16
67	EPA Review of FS Data Report (Draft)	45 days	Sat 4/16/16	Mon 5/30/16
68	Receive EPA Comments - FS Data Report (Draft)	0 days	Mon 5/30/16	Mon 5/30/16
69	Revise EPA FS Data Report (Final)	30 days	Tue 5/31/16	Wed 6/29/16
73	Submittal of FS Data Report (Final)	0 days	Wed 6/29/16	Wed 6/29/16
74	EPA Review and Approval of Data Report (Final)	20 days	Thu 6/30/16	Tue 7/19/16
75	Task 4 – Preliminary (30 Percent) Design	129 days	Wed 7/20/16	Fri 11/25/16
76	Prepare Preliminary (30 Percent) Design (Draft)	60 days	Wed 7/20/16	Sat 9/17/16
80	Submittal of Preliminary (30 Percent) Design to EPA	0 days	Sat 9/17/16	Sat 9/17/16
81	EPA Review of Preliminary (30 Percent) Design (Draft)	45 days	Sun 9/18/16	Tue 11/1/16
82	Receive EPA Comments	0 days	Tue 11/1/16	Tue 11/1/16
83	Prepare Response to EPA Comments	10 days	Wed 11/2/16	Fri 11/11/16
84	Submit to EPA	0 days	Fri 11/11/16	Fri 11/11/16
85	EPA Review and Conditional Approval	14 days	Sat 11/12/16	Fri 11/25/16
86	Task 5 – Intermediate (60 Percent) Design	129 days	Sat 11/26/16	Mon 4/3/17
87	Prepare Intermediate (60 Percent) Design	60 days	Sat 11/26/16	Tue 1/24/17

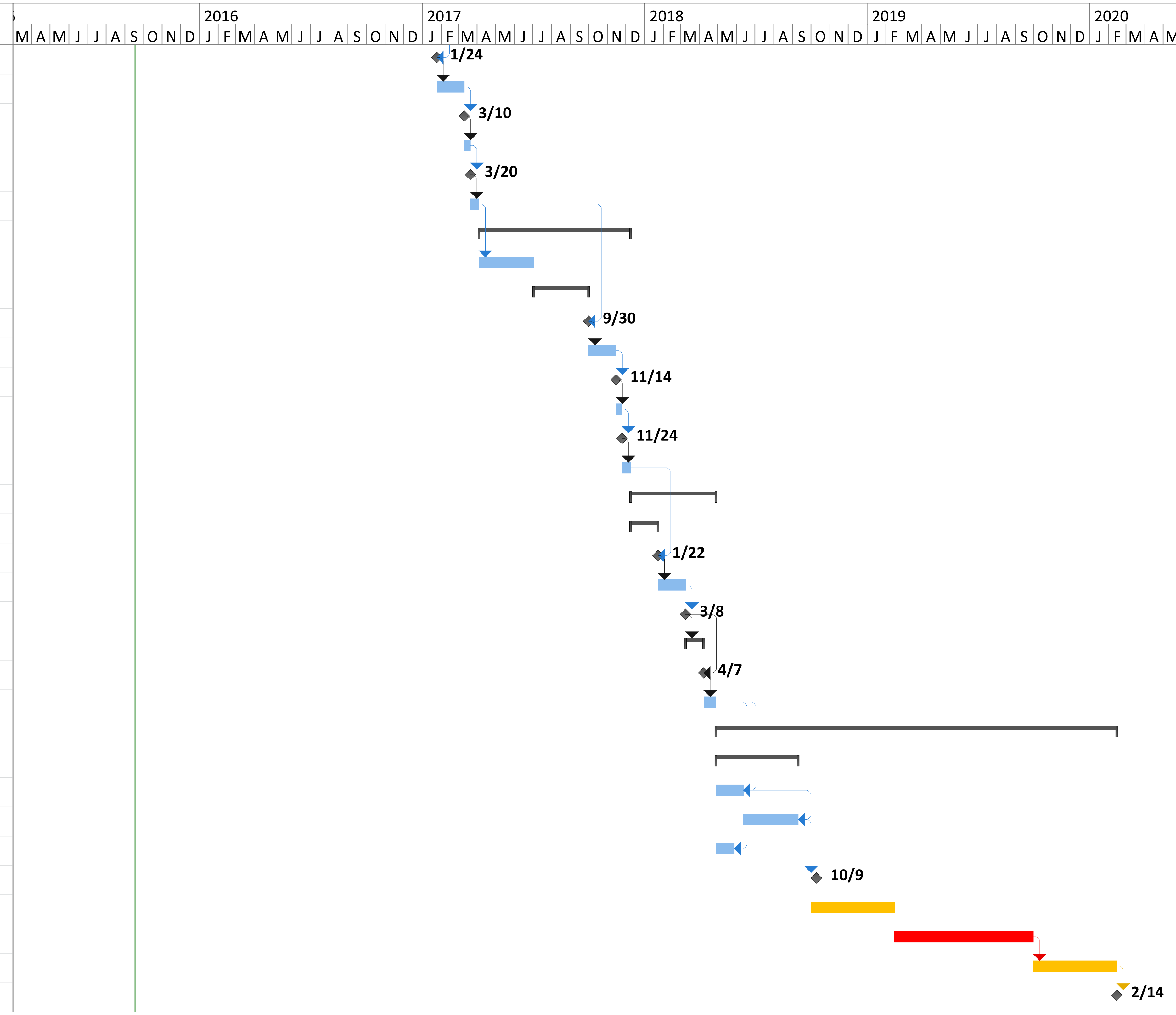


Lockheed West Remedial Design Schedule
Schedule based on a design/build scenario with procurement after the 30% design.
Date: Fri 9/18/15

Task		Summary		Start-only	[	Deadline	
Milestone	◆	Project Summary		Finish-only	]	Progress	

Figure 3-1 Lockheed West Seattle Project Schedule

ID	Task Name	Duration	Start	Finish
91	Submittal of Intermediate (60 Percent) Design to EPA	0 days	Tue 1/24/17	Tue 1/24/17
92	EPA Review of Intermediate (60 Percent) Design	45 days	Wed 1/25/17	Fri 3/10/17
93	Receive EPA Comments	0 days	Fri 3/10/17	Fri 3/10/17
94	Prepare Response to EPA Comments	10 days	Sat 3/11/17	Mon 3/20/17
95	Submit to EPA	0 days	Mon 3/20/17	Mon 3/20/17
96	EPA Review and Conditional Approval	14 days	Tue 3/21/17	Mon 4/3/17
97	Task 6 – Pre-Final (90 Percent) Design	249 days	Tue 4/4/17	Fri 12/8/17
98	Design Build Procurement	90 days	Tue 4/4/17	Sun 7/2/17
99	Prepare Preliminary (90 Percent) Design (Draft)	90 days	Mon 7/3/17	Sat 9/30/17
103	Submittal of Preliminary (90 Percent) Design to EPA	0 days	Sat 9/30/17	Sat 9/30/17
104	EPA Review of Preliminary (90 Percent) Design (Draft)	45 days	Sun 10/1/17	Tue 11/14/17
105	Receive EPA Comments	0 days	Tue 11/14/17	Tue 11/14/17
106	Prepare Response to EPA Comments	10 days	Wed 11/15/17	Fri 11/24/17
107	Submit to EPA	0 days	Fri 11/24/17	Fri 11/24/17
108	EPA Review and Conditional Approval	14 days	Sat 11/25/17	Fri 12/8/17
109	Task 7 – Final (100 Percent) Design	140 days	Sat 12/9/17	Fri 4/27/18
110	Prepare Final (100 Percent) Design (Draft)	45 days	Sat 12/9/17	Mon 1/22/18
114	Submittal of Final (100 Percent) Design to EPA	0 days	Mon 1/22/18	Mon 1/22/18
115	EPA Review of Final (100 Percent) Design (Draft)	45 days	Tue 1/23/18	Thu 3/8/18
116	Receive EPA Comments	0 days	Thu 3/8/18	Thu 3/8/18
117	Revise EPA Final (100 Percent) Design (Final)	30 days	Fri 3/9/18	Sat 4/7/18
121	Submittal of Final (100 Percent) Design (Final) to EPA	0 days	Sat 4/7/18	Sat 4/7/18
122	EPA Review and Approval of Final (100 Percent) Design (Fina	20 days	Sun 4/8/18	Fri 4/27/18
123	Task 8 - Remedial Action	658 days	Sat 4/28/18	Fri 2/14/20
124	Remedial Action Work Plan	135 days	Sat 4/28/18	Sun 9/9/18
125	Remedial Action Work Plan	45 days	Sat 4/28/18	Mon 6/11/18
126	Remedial Action Work Plan EPA Approval	90 days	Tue 6/12/18	Sun 9/9/18
127	Award Remedial Action Construction Contractor(s)	30 days	Sat 4/28/18	Sun 5/27/18
128	Initiate Construction and Remedial Action	0 days	Tue 10/9/18	Tue 10/9/18
129	Remedial Action Construction - Year 1	137 days	Mon 10/1/18	Thu 2/14/19
130	Fish Window Closure Period	228 days	Fri 2/15/19	Mon 9/30/19
131	Remedial Action Construction - Year 2	137 days	Tue 10/1/19	Fri 2/14/20
132	Completion of Construction	0 days	Fri 2/14/20	Fri 2/14/20



Lockheed West Remedial Design Schedule
Schedule based on a design/build scenario with procurement after the 30% design.
Date: Fri 9/18/15

Task		Summary		Start-only		Deadline	
Milestone		Project Summary		Finish-only		Progress	

Section 4
Remedial Design Project Team

The Lockheed West Seattle Superfund Site (Site) remedial design project team is introduced in this section. The project team includes the regulatory Remedial Project Manager, Lockheed Martin's management personnel, and Lockheed Martin's remedial design contractor (remedial design team, pre-design field investigations personnel). Project organization chart and contact information are also presented in this section.

4.1 PRE-DESIGN AND DESIGN PERSONNEL ORGANIZATION

Tetra Tech is the primary contractor to Lockheed Martin for implementation of remedial design for the Site. Tetra Tech will be responsible for project management, coordination with regulatory agencies, and overall implementation of design tasks. Tetra Tech will also be responsible for project deliverables, team resources, project budget and financial controls, scheduling, coordination, and communications. This section provides the organizational structure of the remedial activities based on Lockheed Martin's obligations under the Unilateral Administrative Order (UAO) and associated Scope of Work (SOW), Record of Decision (ROD), and Explanation of Significant Differences (ESD). The project organization is shown in Figure 4-1 and described in this section.

4.1.1 Remedial Action Regulatory Personnel

Remedial Project Manager (Piper Peterson, EPA Region 10)

The Remedial Project Manager (RPM) will be responsible for overseeing potentially responsible party-conducted RD/RA to ensure that the remedy is protective of human health and the environment and to ensure that the remedial action is implemented in accordance with the ROD.

4.1.2 Remedial Action Design Personnel

Lockheed Martin Design Project Manager (Bill Bath, Lockheed Martin)

The Lockheed Martin Design Project Manager will have overall responsibilities for the Site remediation activities. He will oversee all program activities to ensure compliance and perform technical oversight and consultation for all remedial activities. He will be the main point of contact with EPA and other stakeholders, including Tribal representatives for final approval of all necessary actions and adjustments of activities to accomplish project objectives. The Lockheed Martin Project Manager will also assist in overseeing all sediment remediation construction activities, including schedule, budget, and project deliverables for remedial construction; ensuring compliance; providing technical oversight; and implementing necessary actions and adjustments for activities to accomplish project objectives.

Remediation Technical Operations (Matthew Schultz, CDM Smith)

The Remediation Technical Operations will support Lockheed Martin in the management and technical oversight of the project for the Site.

Design Project Manager (Gary Braun, Tetra Tech)

The Design Project Manager (DPM) will be responsible for the management of all pre-design and design aspects of the project for the Site. The DPM will report directly to the Lockheed Martin Project Manager.

Design Project Engineer (Senda Ozkan, P.E., Tetra Tech)

The Design Project Engineer will be responsible for certifying under signature and seal that the remedial design was prepared in accordance with the UAO (EPA, 2015b), the SOW (EPA, 2015c), the ROD (EPA, 2013), and the ESD (EPA, 2015a).

Pre-Design Field Investigation Lead (Keir Craigie, Tetra Tech)

The pre-design field investigation lead will report to the DPM, and will be responsible for implementing the field sampling and analysis plan and the Quality Assurance Project Plan (QAPP).

Field Sampling Lead (Jennifer Kraus, Tetra Tech)

The field sampling lead will report to the field investigation lead and will be responsible for implementing the field sampling and analysis plan. She will make sure that the quality assurance/quality control (QA/QC) requirements for the sampling activities are followed. The on-site field sampling lead will also perform the site safety and health tasks under direction of the Project Environmental and Safety Manager.

Project Environmental and Safety Manager (Tami Froelich, Tetra Tech)

The Project Environmental and Safety Manager (PESM) will have the authority to implement and oversee the Health and Safety Program. The PESM will provide the technical guidance to ensure that all field sampling activities are conducted in compliance with applicable federal, state, and local environmental, health, and safety statutes, regulations, and guidance. The PESM will provide direction to the Site Safety and Health Officer (SSHO).

Site Safety and Health Officer (Jennifer Kraus, Tetra Tech)

The SSHO will fulfill the duties and responsibilities of the environmental and safety supervisor. The SSHO will report to the PESM and the Field Investigation Lead and assist with the implementation of the project's health and safety plan (HASP). The SSHO will help to ensure that operations are performed in compliance with applicable client and site-specific requirements and government regulations. The SSHO will be responsible for the following:

- Ensuring that team members understand the requirements of the HASP policies and procedures through training and communications;
- Conducting daily health and safety briefings;
- Exercising stop work authority when warranted by conditions, in accordance with the project plans;
- Ensuring that site personnel have received required EHS regulatory and program training;
- Supporting the Field Sampling Lead, pre-design investigation lead, and the DPM in accident and incident investigations;
- Functioning as a technical resource for all environmental, safety, loss, industrial, and hygiene issues; and
- Ensuring that the specific responsibilities in the HASP are implemented.

4.2 PROJECT COMMUNICATIONS

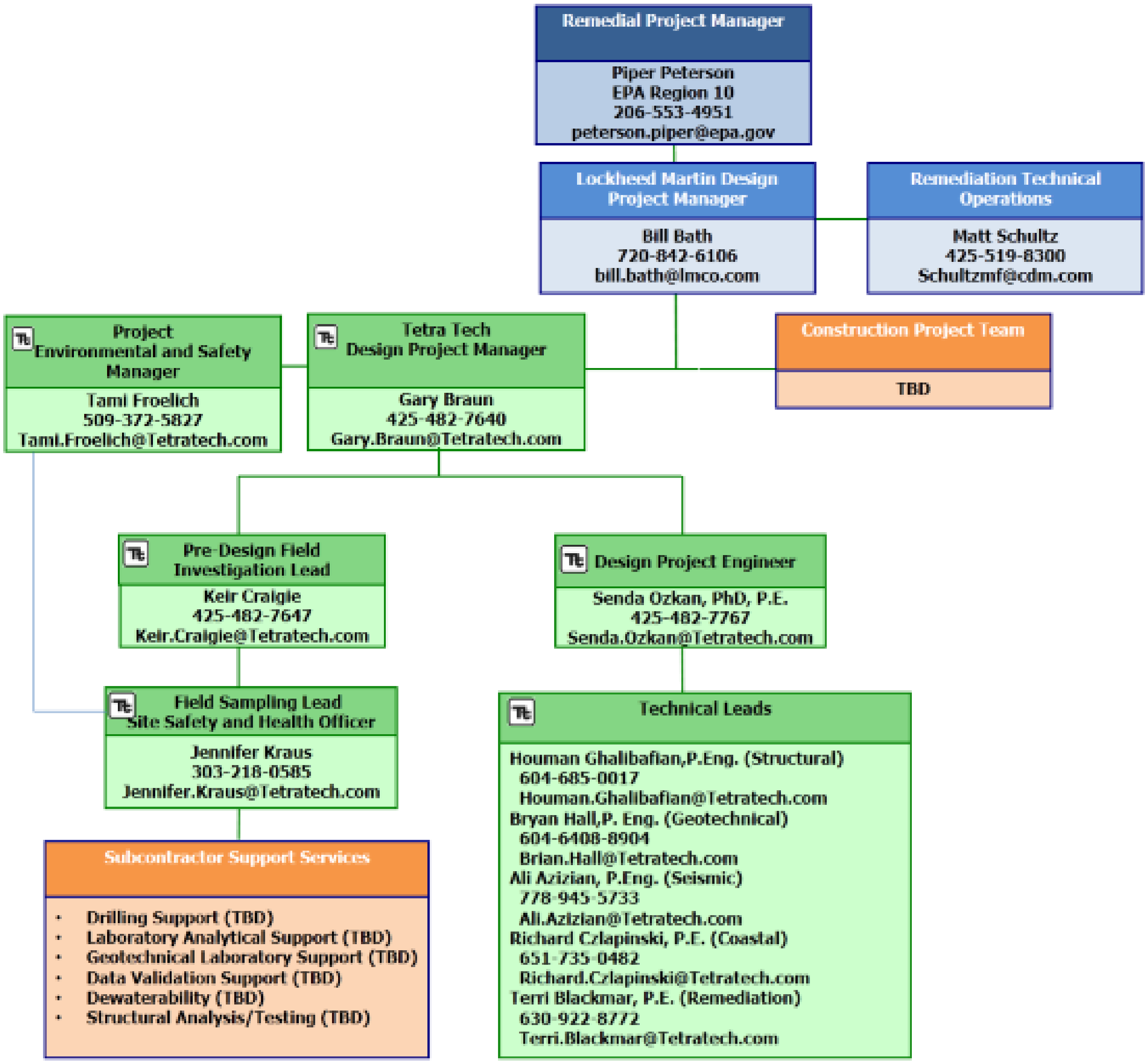
Contact information for the project managers identified to date is presented below. Contact information will be provided in the Final Design for additional key personnel as they are identified throughout the design process.

Piper Peterson, Remedial Project Manager
EPA Region 10
1200 Sixth Avenue
Seattle, Washington 98101
206-553-4951
peterson.piper@epa.gov

Bill Bath, Lockheed Martin Design Project Manager
Lockheed Martin EESH
2550 North Hollywood Way, Suite 406
Burbank, CA 91505-5047
720-842-6106
bill.bath@lmco.com

Gary Braun, Design Project Manager
Tetra Tech
19803 North Creek Parkway
Bothell, WA 98011
425-482-7840
Gary.Braun@tetratech.com

Figure 4-1. Organization Chart



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Section 5

Site Background and Existing Data

This section presents background and environmental setting information regarding the Lockheed West Seattle Superfund Site (Site) and surrounding area. This section also presents a summary of the existing data for the Site.

5.1 SITE LOCATION AND DESCRIPTION

The Site encompasses the in-water portion of what was formerly known as Lockheed Shipyard No.2, located near the confluence of the West Waterway and Elliott Bay, in the city of Seattle, Washington (Figure 1-1). The upland areas of the Site where shipyard support operations formerly took place and where sources to the in-waterway portion of the Site were located is referred to as Remediation Area 5 (RA-5) and was previously remediated under a Model Toxics Control Act (MTCA) cleanup order. The Site is adjacent to the upland areas of Port of Seattle (Port) Terminal 5, which is not part of the Site.

The Site includes the in-water marine sediments where the former Lockheed Shipyard No.2 was located (the shipway and dry docks were located in the water over the sediments). The site also includes a narrow shoreline bank and intertidal sediments along the northern and eastern shorelines, and subtidal sediments that extend from -40 to -50 feet mean lower low water (MLLW) in historically dredged areas. It is impacted by tides, with additional influence from the Lower Duwamish Waterway (LDW) that flows into the West Waterway. In addition, numerous pilings remain within the footprint of the former shipway and pier structures in the northwestern portion of the Site.

Several other Superfund sites resulting from separate industrial operations are located near the Site:

- Pacific Sound Resources (PSR) Superfund Site borders the Site on the west

- Harbor Island Superfund Site, including the following:
    - Todd Shipyard Sediment Operable Unit on the east side of the West Waterway and northwest side of Harbor Island
    - Lockheed Shipyard No.1 Sediment Operable Unit on the west side of Harbor Island along the West Waterway
    - West Waterway Operable Unit
    - East Waterway Operable Unit
- LDW Superfund Site flows into the West and East Waterways of Harbor Island and into Elliott Bay

In addition to these Superfund sites, the Washington State Department of Ecology (Ecology) issued state MTCA cleanup orders for the remediation of four areas (RA-1, -2, -3 and -5) located in the Terminal 5 upland area adjacent to the Site. In addition, there is one upland area (RA-4) associated with the PSR Superfund site. The predominant cleanup action applied to these upland remediation areas was capping to keep soil contamination in place and to prevent surface water infiltration into the underlying groundwater. RA-5 is located in the upland area immediately south of the Site and was the area occupied for former shipbuilding activities.

The 40-acre Site includes approximately 33 acres of state-owned aquatic lands and 7 acres of Port-owned aquatic tidelands, as shown by the color-shared areas on Figure 5-1. The Port-owned tidelands and Port-managed harbor areas (blue-shaded area) are adjacent to the Port's Terminal 5 facility upland operations, which include container transfer and handling associated with marine terminal operations. The state-owned aquatic lands include:

- 18 acres of State Harbor Area in Elliott Bay (brown-shaded area)
- 8 acres of State Harbor Area managed by the Port under a Port Management Agreement, of which approximately 3 acres are located within the harbor area north of the Site, and 5 acres of harbor area are located east of the Site (purple-shaded areas)
- 7 acres of State Waterway in West Waterway managed by the Washington State Department of Natural Resources (DNR) (green-shaded area). The U.S. Army Corps of Engineers (USACE) has jurisdiction for maintaining the West Waterway navigation channel, currently authorized to -34 feet MLLW, which is coincident with the state-platted West Waterway.

5.2 SITE HISTORY

Prior to industrial development in the early 1900s, the Site and surrounding area consisted of an intertidal delta at the mouth of the Duwamish River. Most of the original wetlands and mudflats were lost as progressing dredging and filling created Harbor Island, the West Waterway, and a peninsula area (now known as Terminal 5) near the present location of the Site.

The Site was developed beginning in 1942 by dredging the intertidal areas located on the northern terminus of the current Terminal 5. Multiple dredging events were completed to create working space for dry docks and vessel moorage. Several pier structures were constructed over time as part of the shipyard development. Shipyard activities at the Site began during World War II. A moorage pier south of the Site along the West Waterway is visible in a 1946 aerial photograph (Figure 5-2), along with extensive wood treatment and export operations at the current PSR site to the west.

During the 1960s, construction of piers along the northern portion of the Site (Piers 21 through 24) occurred from east to west. An inlet to the west of the Site was filled for expansion of Terminal 5 by 1965. In the 1970s and 1980s, Site use included ship berthing, repair, and maintenance at three dry docks (two owned by the U.S. Navy and one by Lockheed Martin), moorage along the piers, construction in the shipway, and associated upland activities (Figure 5-3).

Lockheed Martin discontinued operations at the Site in 1987 after approximately 45 years of continuous operations by Lockheed Martin or its predecessors. The Port purchased the Lockheed Martin shipyard property in 1988 and conducted remediation of the uplands part of the Terminal 5 expansion in the latter half of the 1990s.

5.3 CURRENT SITE USE

The upland areas adjacent to the Site are used by the Port for shipping container storage. Occasionally, barges are temporarily moored along the existing pier structures using tug boats. In addition, non-commercial vessel traffic such as recreational boats may pass through the Site. Commercial vessels operating in the vicinity of the Site are controlled by the U.S. Coast Guard and are required to use the established navigational channels and berth approaches.

The Site and adjacent aquatic areas are designated as Tribal Usual and Accustomed (U&A) Fishing Areas. The bank and intertidal portions of the Site are accessible from the water. Access via land is currently restricted due to fencing around Terminal 5.

The current fish advisory for Puget Sound Marine Recreational Area 10 (Elliott Bay) includes no rockfish consumption and no more than two meals per month of flatfish (Washington State Department of Health, 2006). The Site is not a major recreational resource compared with other water bodies in the area but there is Tribal U&A fishing and some recreational fishing in the area.

5.4 POTENTIAL SITE FUTURE USES

The Port envisions expanding Terminal 5 pier structures to include a multi-modal container terminal along the West Waterway. Container ships use the navigational channel and offload in the West Waterway at Terminal 5. In 2010 and 2011, the Port requested Waterway Resource Development Act (WRDA) authorization to revise the navigation channel from its current authorization (-343 feet MLLW) to deeper depths ranging from -51 to -55 feet MLLW. The Port described potential future development in letters to the EPA in November 2010, May 2011, and September 2011. The Port is currently working on a berth modernization at Terminal 5 to handle larger vessels requiring the deeper berth depths (Northwest Seaport Alliance, 2015). The USACE initiated a deepening feasibility study in 2015 that is expected to be finished in 2017 (USACE, 2014).

In addition, the Tribes have treaty rights for unimpeded/unrestricted fishing, clamming, and access to the Site. As the aquatic land manager, DNR is also responsible for permitting water-dependent uses at the Site.

5.5 PREVIOUS SITE INVESTIGATIONS

Since 1984, an extensive series of studies have been independently conducted by Lockheed Martin and the Port to investigate the nature and extent of sediment contamination at the Site (Tetra Tech, 2008). Much of this information was compiled by Parametrix (1994a and b) and by Enviros (1990) to support characterization of the Lockheed Shipyard No.2 site as part of harbor development planning by the Port. Available historical sediment quality information in the vicinity of the Site includes samples collected prior to 1998 and in 2003 as part of a due diligence investigation (Hart Crowser, 2003a). Existing studies and data are further described in Section 6.1.1 below.

5.6 SOURCE CONTROL

Understanding the potential sources of recontamination to the Site is important to determine whether the Selected Remedy will likely remain protective. Historical shipyard operations at the Site were discontinued in 1987 and there is no current ongoing source of contamination from present uses of the Site. However, there are upland and upstream sources of contamination in the vicinity of the Site. These potential off-site sources could represent future sources of contamination to the Site sediments including potential spills from nearby facilities, wastewater discharges, combined sewer overflows, storm water discharges, and contaminated groundwater discharges (Figure 1-3).

Surface water and sediment conditions at the Site are influenced by the natural counterclockwise flow of water and tidal influences in Elliot Bay. Elliott Bay is affected by nearby urbanization, and overall concentrations of certain contaminants in bay sediments are higher than concentrations identified as being protective of human consumption of seafood. Thus, contaminated sediment could migrate to the Site as a result of off-site sediment transport from adjacent areas after completion of remediation.

Based on sediment sample testing at the PSR site (EPA, 2009) as well as evaluation performed for the Remedial Investigation/Feasibility Study (RI/FS; Tetra Tech, 2012), contaminant of concern (COC) concentrations in Site sediments may reach a long-term equilibrium level above natural background but still below Sediment Quality Standards (SQS) concentrations in the post-construction period as a result of elevated sediment concentrations from Elliott Bay migrating to the Site. Although some level of recontamination will occur at the Site, remediation of individual sites such as PSR, the Site, Todd Shipyards, Lockheed Yard No.1, and East and West Waterways should result in incremental reductions in background concentrations in the larger Elliott Bay.

5.7 HABITAT AND NATURAL RESOURCES

The aquatic environment at the Site consists of estuarine waters and sediments. The shoreline habitat is typical of the industrial shoreline in much of the Duwamish Waterway with armoring and sheet pile bulkheads, along with broken pilings, deteriorating wooden bulkheads, and debris. A single, small intertidal beach area of about 2 acres is present along the West Waterway between the Terminal 5 pier and the South Florida Street Outfall. Current shoreline conditions within the remainder of the Site boundary indicate a highly modified and impacted industrial shoreline with little to no natural intertidal habitat.

Surface water at the Site is predominantly tidal with additional influences from river flows from the West Waterway at the mouth of the Duwamish/Green River watershed. The Site is affected by relatively low-salinity water from the Duwamish River that forms an approximate 3- to 6-foot layer over denser saline waters. The combination of tidal and river flows results in a consistent flow across the Site from west to east and does not appear to be a source of erosion.

Flora and fauna of the in-water area and shoreline include bivalves, crustaceans, and worms in the fine sediments. Crustaceans (such as shrimp and crabs) and mollusks (clams and snails) are typically found in coarser sediments. The Site environment also supports birds (such as sandpiper), crabs, resident fish (such as perch, sculpin, rockfish), as well as anadromous fish (such as salmon).

Puget Sound Chinook salmon are listed as threatened under the Endangered Species Act (ESA), as noted earlier in Section 2.2. Based on the findings of the RI/FS (Tetra Tech, 2012), critical habitat does not appear to be present at the Site. However, EPA will consult with and obtain Biological Opinions from appropriate agencies. For any action that may impact listed salmon species, Federal agencies must confer with the National Marine Fisheries Service (NMFS) at the National Oceanic and Atmospheric Administration and with the U.S. Fish and Wildlife Service.

There are no known cultural resources such as Native American graves, sacred sites, historic sites or structures, or archaeological resources associated with the Site.

5.8 SITE PHYSICAL CHARACTERISTICS

The Site consists of approximately 40 acres of in-water sediments where the former Lockheed Shipyard No. 2 was located. It is tidally affected with additional influence from the LDW that flows into the West Waterway. The Site is predominantly subtidal, with mudline elevations extending from -10 feet MLLW to -40 to -50 feet MLLW in historically dredged areas. Shallower areas are present beneath the former shipyard piers (elevations of -20 to -30 feet MLLW). The intertidal and shoreline portions of the Site extend from mean high higher water at +11.3 feet MLLW to -10 feet MLLW.

As noted earlier, the Duwamish Estuary and Elliott Bay have experienced extensive development and urban growth during the 20th century. Tidal flats and marshes that once dominated the mouth of the river were dredged and filled to form Harbor Island and the upland areas of the Site. The shoreline is densely armored with riprap, and includes wooden and steel retaining walls or bulkheads. Since closure of the shipyard, the Port has demolished Piers 21 and 22 and removed the decking from Piers 23 and 24. Pilings for these piers and the former shipway area still exist, and the Port is required to remove pilings between the inner and outer harbor area per the lease termination agreement with DNR, the current manager of the state-owned lands in this portion of the Site. A narrow intertidal zone extends along the landward edge of the Site, wrapping around the eastern and northern shoreline between the West Waterway and the PSR Superfund site and deepens toward offshore areas (Figure 5-4). Numerous pilings remain within the footprint of the former shipway and pier structures remain in the northern portion of the Site.

5.9 SURFACE AND SUBSURFACE SEDIMENT CHARACTERISTICS

The shoreline area is composed of medium sand, shell hash, small- to medium-size cobbles, medium to large riprap, concrete keel blocks, cut-off and broken-off wood pilings, and debris, including trash, wire rope, concrete and ductile iron piping, and portions of deteriorated wooden bulkheads. Numerous debris piles and multiple pilings are present in the intertidal and subtidal areas of the former dry docks and shipway.

In the aquatic area, the sediment profile is composed of an upper layer of three feet of very loose sandy silt, followed by a 10- to 20-foot layer of interbedded soft sandy silt and loose silty sand, underlain by medium dense to dense silty sand to a depth of 75 to 100 feet, below which the material becomes very dense. This pattern is consistent with deltaic deposits of alluvial origin from the Duwamish River system or fill derived from these materials. These delta deposits transition to glacial till at about 150-foot depth; below 300 feet the glacial till behaves as bedrock. Bedrock at the Site is at a range of 650 to 1,000 feet (Hart Crowser, 2003a).

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TETRA TECH

Lockheed West Seattle Superfund Site, Seattle, WA

Figure 5-1
Current Management and Ownership

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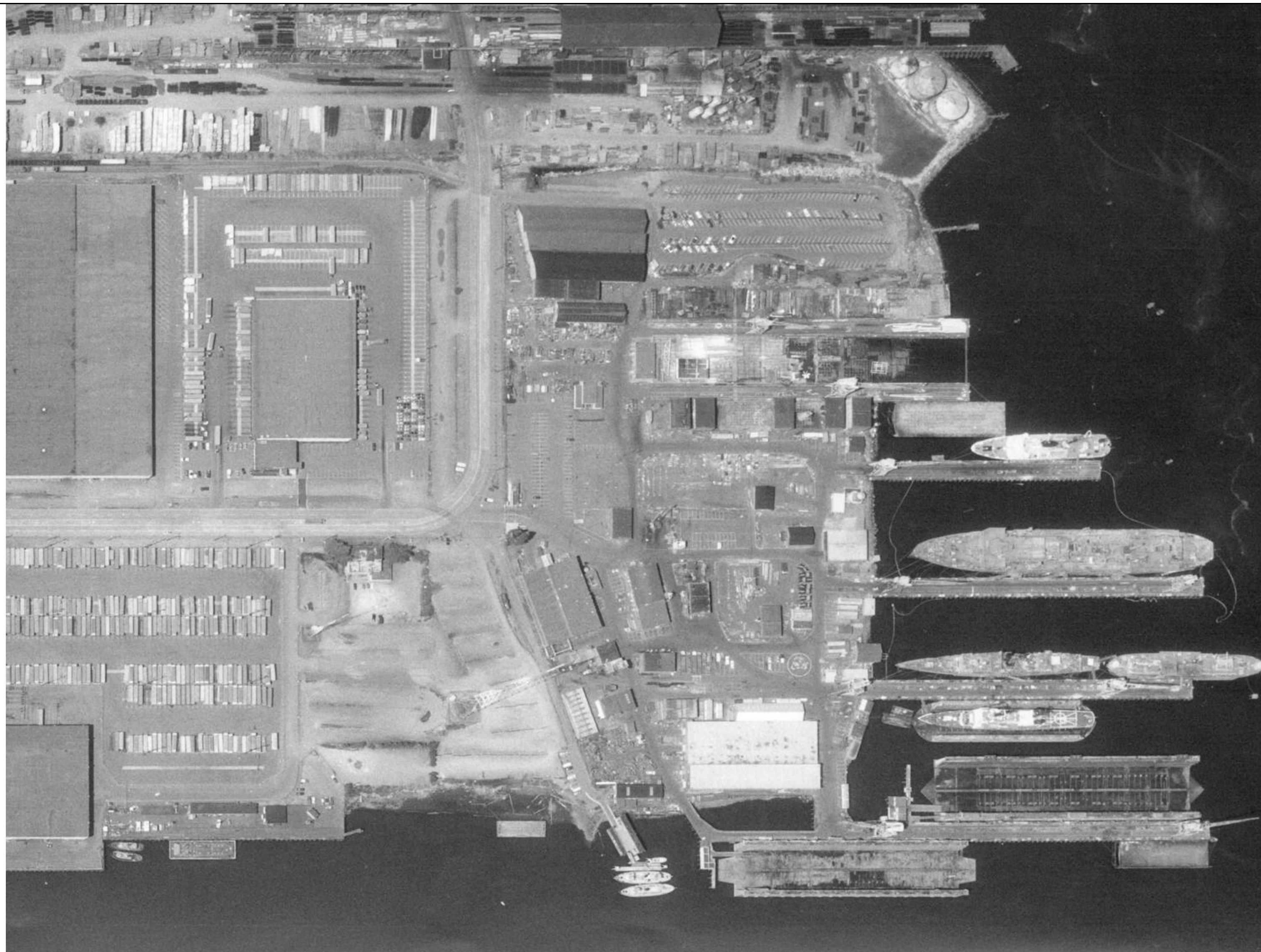
TETRA TECH

Lockheed West Seattle
Superfund Site
Seattle, WA

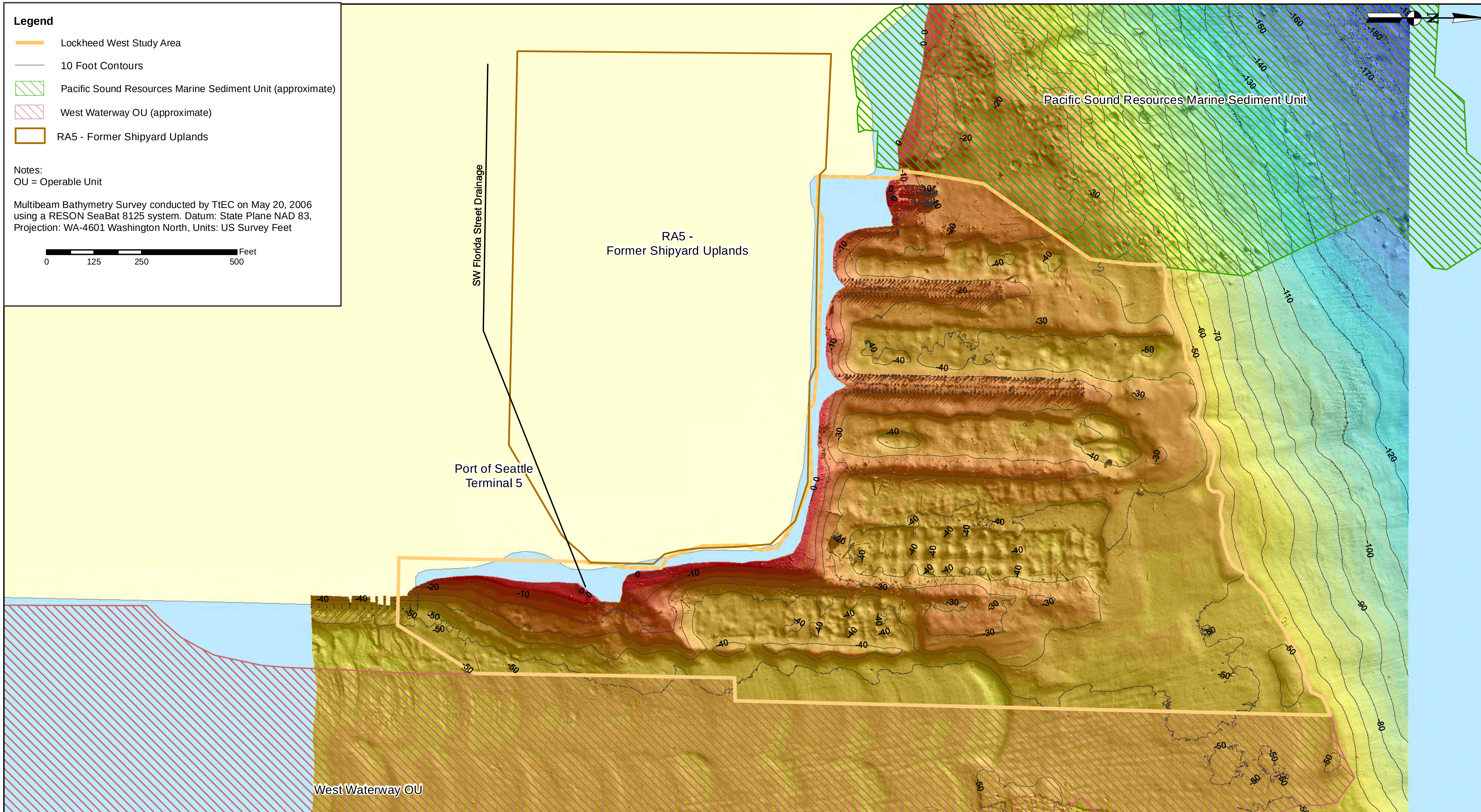
Figure 5-2
1946 Aerial Photograph



TETRA TECH

Lockheed West Seattle
Superfund Site
Seattle, WA

Figure 5-3
1980 Aerial Photograph



TETRA TECH

Lockheed West Seattle Superfund Site, Seattle, WA

Figure 5-4
Lockheed West Site Bathymetry

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Section 6
Pre-Design Investigation Scope and Rationale

The Lockheed West Remedial Investigation/Feasibility Study (RI/FS) collected a significant amount of data that was used to define the nature and extent of the impacted area. However, there are additional data needs to support remedial design efforts, such as delineating areas affected by contaminants of concern (COCs) and refining dredging limits. Other issues related to remedial design include presence of debris and remnant piers, riprap piles that provide structural support, the ongoing operations of the Port of Seattle (Port) and its tenants, and the physical condition of shoreline structures that will be affected during the remediation. This section describes these data gaps and data needs that will be addressed as part of the pre-remedial design field work. The types of pre-design investigation activities planned for the field work are described in this section.

6.1 DATA GAP ANALYSES

6.1.1 Existing Data

As noted in Section 5.5, starting in 1984, Lockheed Martin and the Port independently conducted an extensive series of studies to determine the nature and extent of sediment contamination in the Lockheed West Seattle Superfund Site (Site) and vicinity (Tetra Tech, 2008). Much of this information was compiled by Parametrix (1994a and b) and by Enviros (1990) to support characterization of the Lockheed Shipyard No. 2 site for the Southwest Harbor Cleanup and Redevelopment Project. Available historical sediment quality information in the vicinity of the Site includes samples collected prior to 1998 and those collected in 2003 by Hart Crowser as part of the former Lockheed Shipyard No. 2 due diligence investigation (Hart Crowser, 2003a). Previous work also supported studies for the Harbor Island RI/FS (Weston, 1993), evaluation of sediments in the West Waterway of the Duwamish River, and other sediment quality evaluations. Historical and recent sample locations are shown on Figure 6-1.

Environmental samples from this historical work were summarized in Appendix A of the *RI/FS Work Plan* (Tetra Tech, 2008) and were compiled from the Washington State Department of Ecology (Ecology) SEDQUAL database and Hart Crowser (2003a). In addition to bulk chemical analysis, sediment characterization work also included the following tests for some of the samples collected:

- Nineteen bioassay tests;
- Eight infauna sampling locations;
- Five surface samples tested using the Toxicity Characteristic Leaching Procedure;
- Forty benthic flux samples from two locations; and
- Sixty interstitial porewater samples from six squeeze core locations.

Hart Crowser (1995) also completed 24 additional subsurface geotechnical borings for the Port to assess sediment types and physical properties throughout the Site and the adjacent West Waterway (Tetra Tech, 2008). Data from these borings were used for engineering design and stability analysis for development of Terminal 5 by the Port.

In addition to the recent sediment data collected in direct support of the Lockheed West RI, data from other sediment investigation efforts was incorporated into the RI to the extent that the data were found to be valid and usable for the intended purposes. These include data from the following previous studies:

- **Sediment Quality Study in Elliot Bay (Ecology, 2009).** In 2007, Ecology conducted a sediment quality study in support of the Urban Waters Initiative. This study included collection of surface sediment samples from Elliot Bay, which were analyzed for metals, polychlorinated biphenyls (PCBs), pesticides, semivolatile organic compounds (SVOCs), conventional parameters, and grain size. The samples for this study were grouped into three general categories: Basin, Urban, and Harbor areas.
- **Lockheed Shipyard No. 2 Sediment Characterization (Hart Crowser, 2003a)**. Surface sediment samples were collected to update the Site environmental status. Laboratory analyses included metals, PCBs, pesticides, SVOCs, volatile organic compounds (VOCs), dioxins conventional parameters, and grain size.
- **Southwest Harbor Puget Sound Dredge Disposal Analysis–Related Sediment Quality Investigation (Enviros, 1992)**. This investigation included the collection of subsurface sediment core data, which were analyzed for metals, PCBs, pesticides, SVOCs, VOCs, and conventional parameter analysis.

- **Southwest Harbor RI Sediment Quality Investigation (Enviros, 1991).** Subsurface core data were collected and analyzed for metals, PCBs, SVOCs, VOCs, and conventional parameters.
- **Lockheed Shipyard No. 2 Sediment Characterization and Geochemical Study (Enviros, 1990).** This study included the collection of sediment core data for metals, PCBs, pesticides, SVOCs, VOCs, and conventional parameters analyses.

The Site remedial investigation fieldwork was conducted from 2006 through 2008 and is summarized in the Remedial Investigation/Feasibility Study (Tetra Tech, 2012). Field activities and collected data include the following:

- Performance of a high-resolution multi-beam bathymetry survey, shoreline conditions survey, and topographic survey;
- Collection of surface sediment samples from the intertidal and subtidal areas;
- Collection of subsurface sediment samples from the subtidal area;
- Collection of pore water and surface water samples; and
- Performance of clam reconnaissance surveys and collection of clam tissue samples.

6.1.2 Conceptual Site Model

The primary source of sediment contamination at the Site is from the historical shipyard operations and related discharges from those operations. Contaminants were released to the surface waters during historic shipyard activities and accumulated in the site sediments. Contaminants in the sediment are found in the areas of the major shipyard operations including the dry docks and shipway.

6.1.3 Nature and Extent of Sediment Contamination

Metals, PCBs, tributyltin, and PAHs are the most frequently detected contaminants in sediment samples collected from the Site. Surface samples with exceedances of the Washington State Sediment Quality Standards (SQS) are shown on Figure 6-2. The results from the remedial investigation sampling found that the highest concentrations of contaminants in the sediment were generally located in the area of the former dry docks and former shipway. The concentrations of contaminants tend to decrease away from these areas toward the Site boundaries. Concentrations in the subsurface sediments are shown in Figure 6-3. The higher concentrations of contaminants in the sediments are primarily found in the area of the former dry docks. At a small number of locations the deepest sample interval collected during the remedial investigation had concentrations above the Washington State SQS.

6.1.4 Existing Geotechnical Data

Previous geotechnical investigations conducted at the Site, the nearby Pacific Sound Resources Marine Sediment Unit, and the Lockheed Shipyard #1 Sediment Operable Unit include studies conducted by Enviros, Hart Crowser, URS, and Tetra Tech (Enviros, 1990; Hart Crowser, 1995; URS, 2003; Hart Crowser, 2003b; Tetra Tech, 2008). The Hart Crowser study provides the most site-specific and extensive geotechnical information at the Site. However, the study does not include any geotechnical investigation near the shore to characterize the near shore sediment of the Site. Limited upland borings provide information about the upland substrate (Hart Crowser, 1995).

6.1.5 As-built and Current Conditions of Shoreline Structures

As-built engineering design of the shoreline structures or an engineering inspection of current degradation conditions are not available. An engineering assessment of the stability of shoreline structures requires sufficient data to determine the original design criteria and current conditions.

6.2 FIELD RECONNAISSANCE AND SITE VISITS

A shoreline survey was conducted in 2006 during the remedial investigations (Tetra Tech, 2012). The observations made during the shoreline surveys are presented in Figures 6-4 through Figure 6-8. Slopes along the shoreline ranged from very shallow to vertical. Substrates observed in the shoreline area included medium sand, shell hash, small- to medium-size cobbles, medium to large riprap, concrete keel blocks, cut-off and broken-off wood pilings, and debris, including trash, wire rope, concrete and ductile iron piping, and portions of deteriorated wooden bulkheads. Biota observed included crabs, barnacles, algae, kelp, starfish, mussels, and clams.

A recent field reconnaissance Site visit was carried out during a low tide on May 5, 2015, to identify the structures that may be affected by remediation dredging and to review the overall condition, corrosion and deterioration of these structures. The field reconnaissance included a walk along the shoreline within the limits shown in Figure 6-9, and visual review and photography of the structures (Appendix A). Access to the Site was provided by boat.

General shoreline conditions were similar to the observations made in 2006. Shoreline slopes and structures that may be affected by dredging were visually inspected. Based on the observations, an evaluation framework for shoreline structures were outlined, the information gaps were identified (Section 6.4) and an inspection and testing program required to obtain sufficient information for geotechnical stability and structural assessment was proposed (Section 7.3 and 7.4).

6.3 SHORELINE STRUCTURES

The following existing structures have been identified within the shoreline limits shown in Figure 6-9. Photographs of the structures are included in Appendix A. The structures identified during the Site visit are highlighted in the list below.

1) The sheet pile wall on the west side of the Shipway. This sheet pile wall runs continuously from the top of the Shipway slope, turns at the corner behind Pier 26 and continues towards west until the upland and shoreline slope meet. This sheet pile will be affected if the piles within the Shipway are removed and the area within the Shipway is dredged. See Photos 1 through 9 in Appendix A.

2) The sheet pile wall on the east side of the Shipway near the top of the ramp. This sheet piling is the end section of the sheet pile bulkhead that runs parallel to the shoreline behind Pier 25. This sheet piling may be affected if the piles within the Shipway are removed and the area within the Shipway is dredged. See Photo 10 in Appendix A.

3) Buried bulkheads/sheet pile walls between Piers 25 and 24 and between Piers 24 and 23. These sheet piles are buried behind the riprap and will not be affected by dredging as long as the riprap is stable. See Photos 11 and 12 in Appendix A.

4) The sheet pile wall near the northeast corner of the shoreline behind Pier 22A. This sheet pile will be affected by dredging in front of it. See Photos 13 to 23 in Appendix A.

5) Pier 22A, unless the pier is removed prior to dredging. See Photos 22 and 23 in Appendix A.

6) Concrete structure supported on timber piles. This structure is near the top of the slope and will not be affected by the remediation as long as the shoreline slope that supports the structure is stable. See Photos 24 to 26 in Appendix A.

7) The concrete pier on the east side of the site. It is understood that dredging will not be carried out at this location and that this pier will not be affected by the remediation work. See Photo 27 in Appendix A.

8) Storm water outfall (Florida St) along West Waterway just south of the concrete pier. This outfall is currently protected by riprap armoring on both sides and on top of most of the pipe. If dredging is required in nearby intertidal areas, an offset to the edge of the existing

riprap will be established to avoid disturbance of this structure. See Photos 28 and 29 in Appendix A.

9) Light masts on the upland Terminal 5 boundary. These structures will not be affected by the dredging as long as the shoreline slopes are stable. See Photos 26 and 27 in Appendix A.

The main structures that may be affected by dredging are the sheet pile wall on the west of the Shipway (1), the sheet pile wall on the east of shipway (2), and the sheet pile wall near the northeast corner of the shoreline (5). The buried bulkheads will not be affected by the dredging as long as the shoreline slopes are stable. The following observations were made regarding the general condition of the sheet pile bulkheads within the shipway and near northeast corner that may be affected by the remedial action. It is noted that the following condition rating is solely based on general visual observation of the sheet piles during the Site visit. Thorough inspection and condition assessment will be required for appropriate rating of these structures.

- Sheet pile bulkhead at Shipway: as depicted in Photos 1 to 9 in Appendix A, the sheet pile bulkhead on the west side of the Shipway appears to be generally in serious condition with severe corrosion, stratified rust and cross sectional loss of the sheet piles, the walers (horizontal support pieces), and the tie rods. The walers have failed in several locations where the sheet pile wall appears to have been deformed. A quantitative structural evaluation will be required to determine the load bearing capacity and to confirm the condition assessment rating of the structure.
- Sheet pile bulkhead near northeast corner: as depicted in Photos 13 to 23 in Appendix A, the sheet pile bulkhead near the north east corner of the shoreline appears to be generally in poor condition with major corrosion, stratified rust and cross sectional loss of the sheet piles. The sheet pile wall does not have walers on the outside; however, there may be walers on the concealed face of the sheet pile. The general condition of the walers and tie rods, if existing, is not determined. A quantitative engineering evaluation will be required to confirm the condition assessment rating of the structure and to determine its load bearing capacity.

6.4 SHORELINE AND BATHYMETRY SURVEY

6.4.1 Extent of Riprap along Shoreline

Extent of riprap along the shoreline needs to be better defined during the remedial design to determine the extent of removal and perform geotechnical stability analysis of shoreline slopes. The toe of riprap will be determined by the bathymetry survey and/or poling.

6.4.2 Sediment Bathymetry, Subsurface Debris and Obstructions

To support the remedial design, updated and current bathymetry data will be collected to evaluate changes in the Site since the prior survey was completed in 2006 (Figure 6-10). In addition, a debris survey will be performed to determine the amount and type of material present in the dredge areas to be managed during the remediation. The debris survey will include a sidescan sonar survey to identify debris exposed above mudline and a magnetometer survey to detect any ferrous metallic objects that may interfere during dredging.

6.5 DATA GAP ANALYSIS/DATA NEEDS

6.5.1 Delineation of Contamination

Additional sampling has been identified to address several data gaps in contaminant characterization at the Site. These gaps include the following:

- Depth of contamination above remedial action levels at several historic sampling locations across the Site (at locations where the depth of contamination was not found in earlier sampling efforts)
- Determination of required depth of sediment removal in the shipway area (only surface samples were collected previously so cores are needed to characterize the depth of SQS exceedances)
- Determination if accumulated material on the concrete area of the shipway is contaminated to levels requiring removal
- Determination of the required depth of sediment removal in the intertidal areas (between -10 and 4 feet MLLW as only a limited number of surface grabs were collected earlier)
- Determination of the extent of sediment contamination on the shoreline slope (specifically the area between former Piers 23 and 24, adjacent to former Dry Docks 2 and 3 and adjacent to former Dry Dock 1)
- Determination of the amount of sediment removal required under the old pier structures

6.5.2 Dewatering Characteristics of Sediment

Handling of dredged sediment is highly dependent on the dewatering characteristics of the sediment, which is currently identified as a data gap to continue the remedial design:

- Determination of the dewatering characteristics of the dredged sediment in specific dredge areas (i.e., shipway, Dry Dock 1 area, and the Dry Docks 2 and 3 area)

6.5.3 Geotechnical and Structural Stability

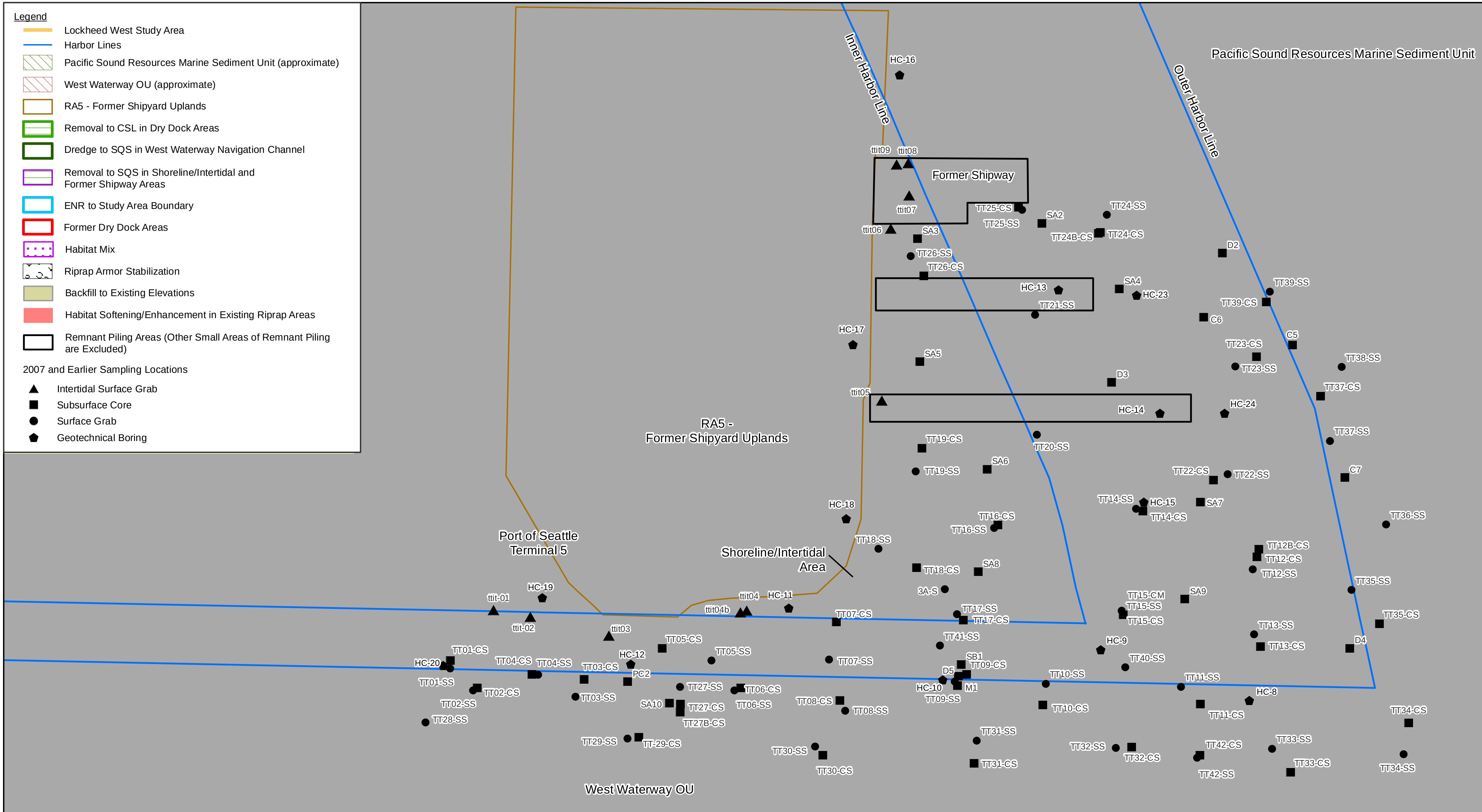
Geotechnical stability of areas that would be potentially impacted by dredging in the former dry dock areas, and removal along the shoreline will be evaluated. Current conditions of shoreline structures in the areas potentially affected by dredging in the shipway and near shoreline will be determined, so that a structural assessment can be performed to discuss potential structural risk mitigation strategies for safe dredging. The following data gaps are identified, and will need to be completed, to perform these evaluations:

- Determination of geotechnical strength, seismic parameters, and physical characterization of sediment
- Determination of as-built structural design and current degradation conditions (e.g., corrosion, strength, etc.) of structural elements

Sampling locations required to address these data gaps are outlined in Section 7, including the rationale, numbers of locations, and estimated numbers of samples for analyses.

6.5.4 Shoreline, Bathymetry, Debris Survey

- Determination of extent of toe of riprap slopes
- Determination of current bathymetry data
- Determination of the amount and type of debris present in the dredge areas to be managed during the remediation



Notes:
AC = Acre
CSL = Cleanup Screening Level
CY = Cubic Yard
ENR = Enhanced Natural Recovery
SQS = Sediment Quality Standard

Lockheed West Site
Seattle, WA

Figure 6-1
Historical Sample Collection
Pre-1998 to 2007

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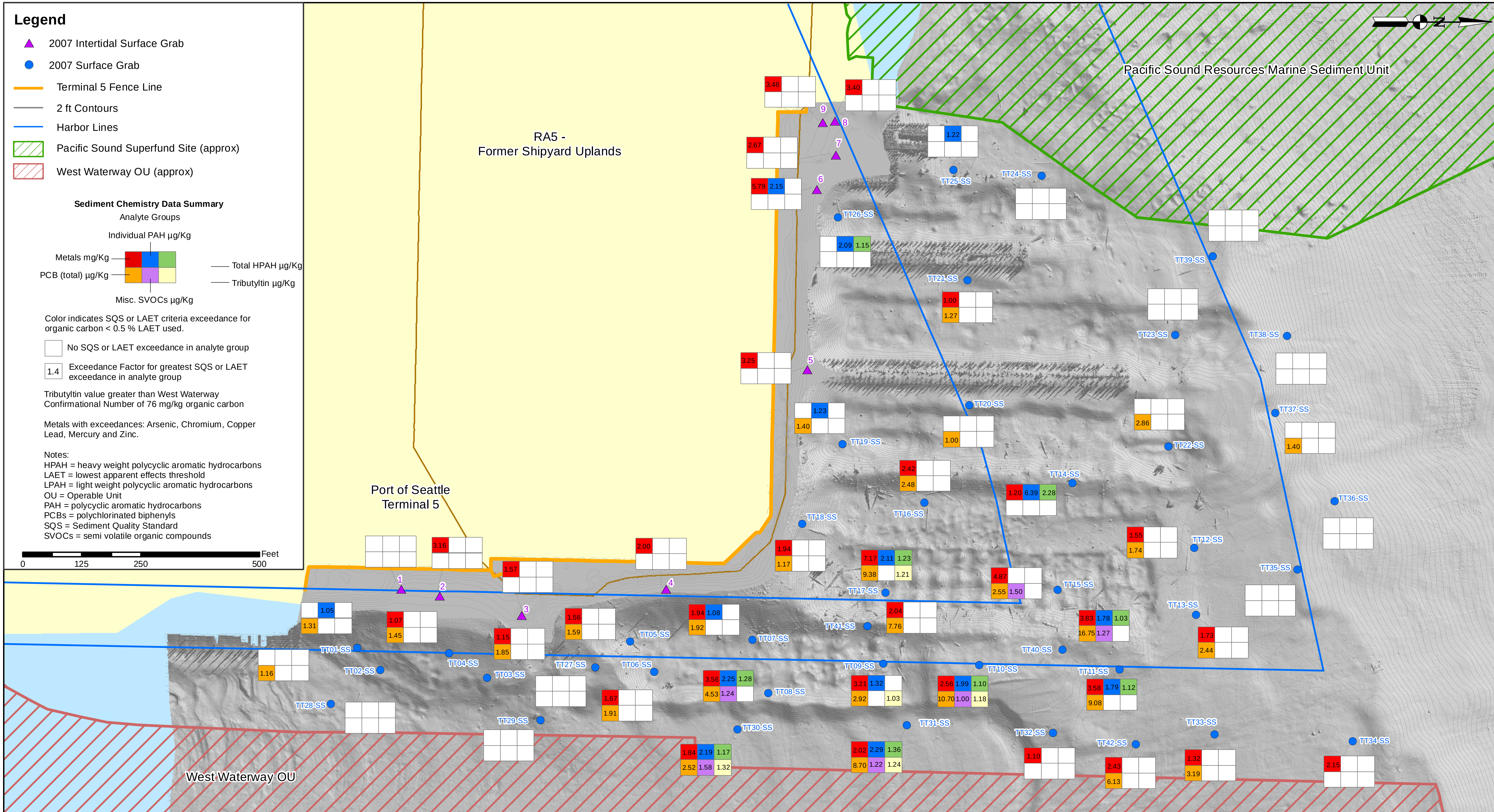

TETRA TECH

Lockheed West Site
Seattle, WA

Figure 6-2
Exceedances of Sediment Quality Standards in Surface Sediment Samples from 2007 (Remedial Investigation Data)

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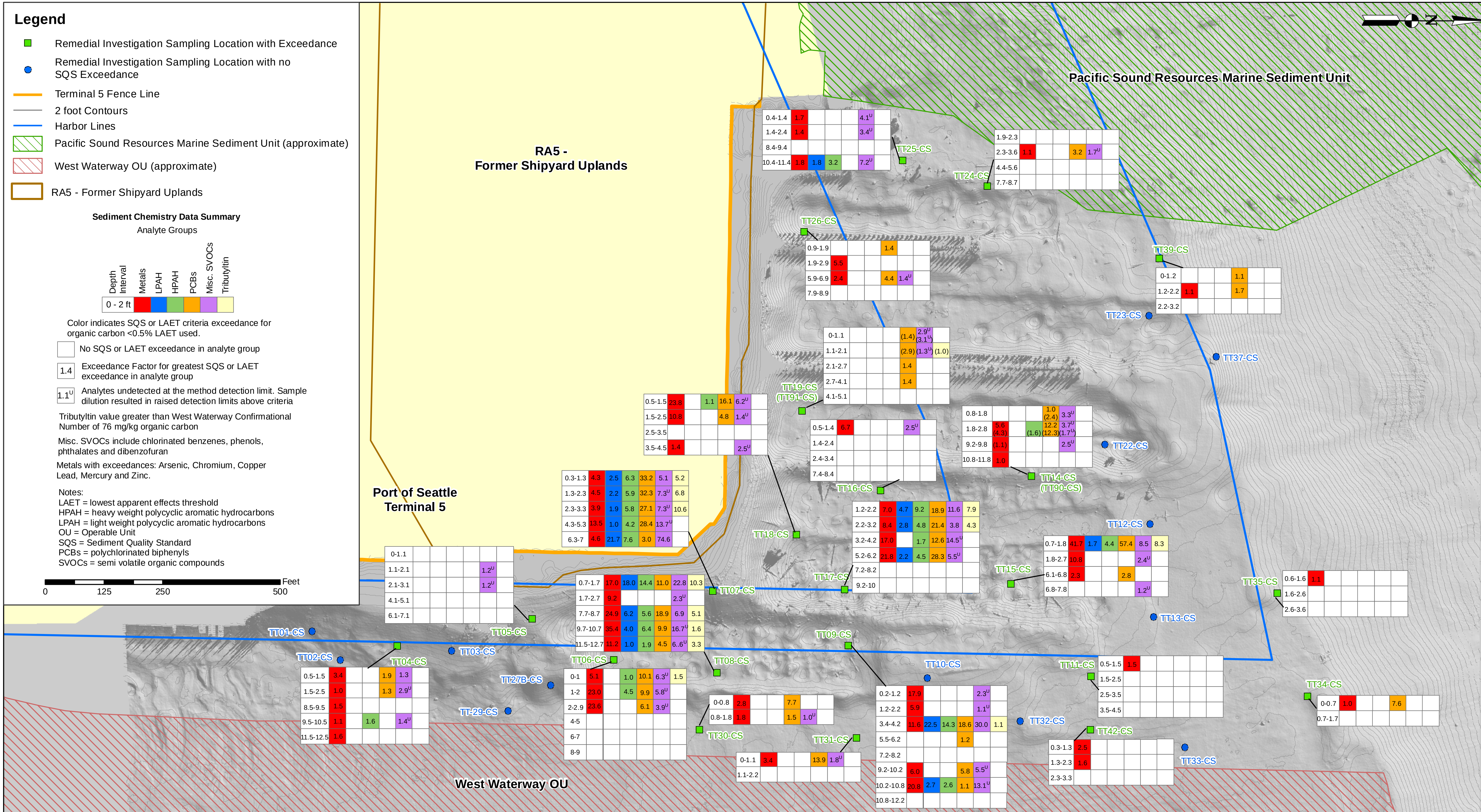

TETRA TECH

Lockheed West Seattle Superfund Site
Seattle, WA

Figure 6-3
Exceedances of Sediment Quality Standards in Subsurface Sediment Samples from 2007 (Remedial Investigation Data)

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egend

manhole	pile line	scrap
seeps	riprap	roots
pile	top of bank	cobble
riprap	wooden bulkhead	sand
	stormwater outfall	

Aerial Photo Source: Google Earth, 2006

TETRA TECH

Lockheed West Seattle
Superfund Site
Seattle, WA

Figure 6-4
Shoreline Survey Observations - 2006
Map 1

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Legend

pile
pipe
concrete
top of bank
wooden bulkhead
wall

Aerial Photo Source: Google Earth, 2006

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Superfund Site
Seattle, WA

Figure 6-5
Shoreline Survey Observations - 2006
Map 2

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(b)(4) copyright

Legend

top of bank

wooden bulkhead

bulkhead

Aerial Photo Source:
Google Earth, 2006

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Lockheed West Seattle
Superfund Site
Seattle, WA

Figure 6-6
Shoreline Survey Observations - 2006
Map 3

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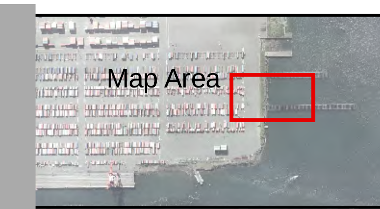

Legend

outfall

top of bank

bulkhead

N

Aerial Photo Source:
Google Earth, 2006

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Lockheed West Seattle
Superfund Site
Seattle, WA

Figure 6-7
Shoreline Survey Observations - 2006
Map 4

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(b)(4) copyright

Legend

concrete

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Lockheed West Seattle
Superfund Site
Seattle, WA

Figure 6-8
Shoreline Survey Observations - 2006
Map 5

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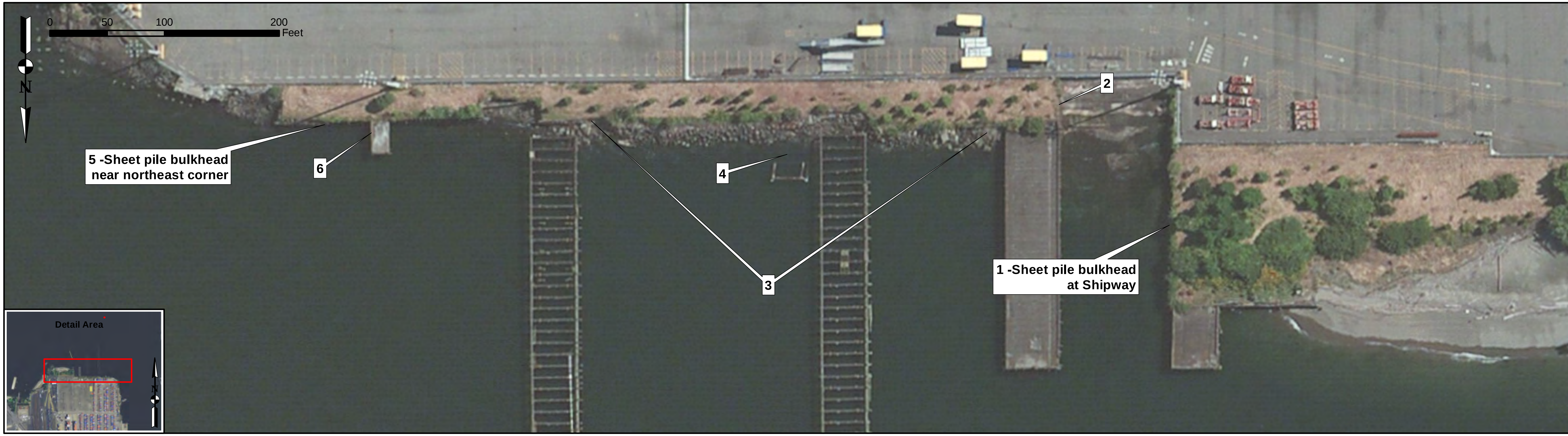

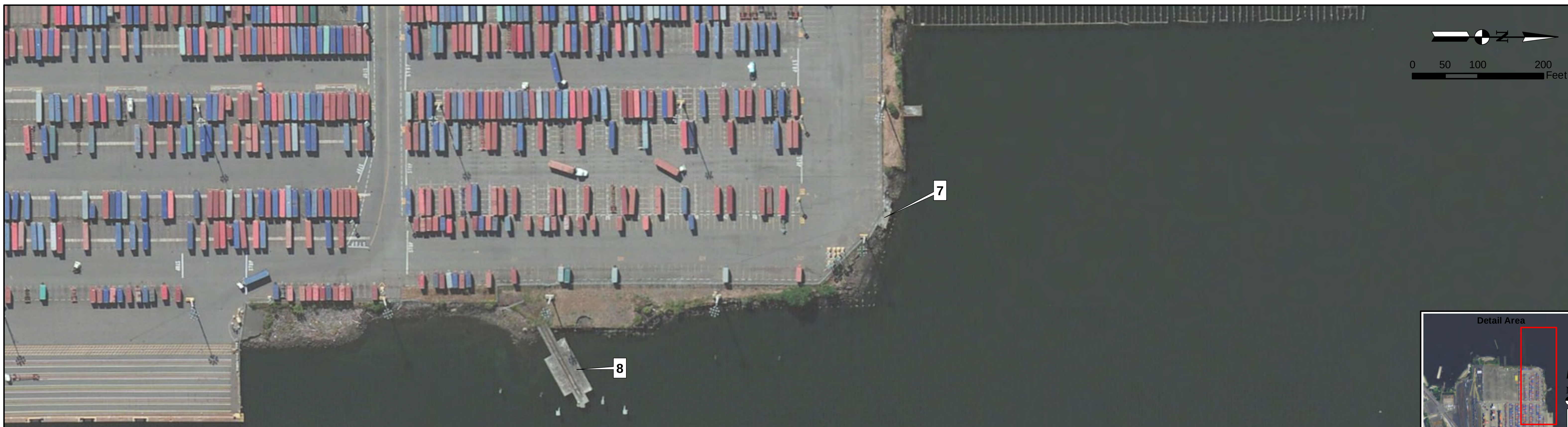

TETRA TECH

Lockheed West Seattle
Superfund Site
Seattle, WA

Figure 6-9
Field Reconnaissance Map - 2015

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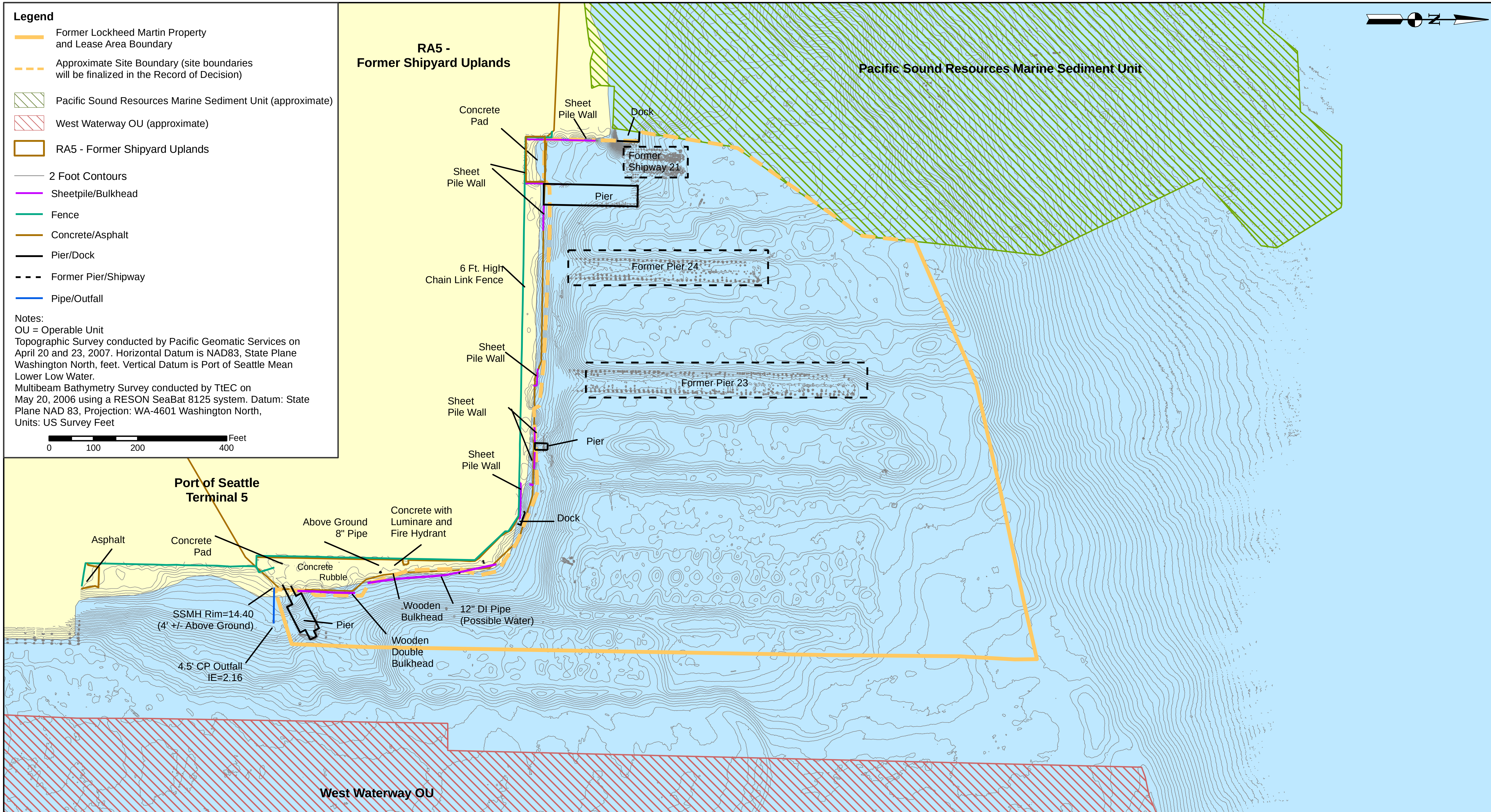

TETRA TECH

Lockheed West Seattle Superfund Site Seattle, WA

Figure 6-10 Intertidal Topography and Bathymetry Contours

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Section 7
Field Sampling and Analysis Plan

The field sampling and analysis activities are discussed below. These activities were developed to address the data gaps identified in Section 6 for geotechnical, structural and contaminant characterization. The scope of the data collection and evaluation for the pre-design phase is based on the overall objectives of the remedial design as set forth in the Record of Decision (ROD), Unilateral Administrative Order (UAO), the Scope of Work (SOW), and the identification of data gaps presented above. Associated documents for field sampling include the Quality Assurance Project Plan (QAPP) in Appendix B, and the Health and Safety Plan (HASP) in Appendix C.

The objective of this project is to collect data to address data gaps in the characterization of the sediments, the geotechnical characteristics of both the shoreline and sediments, the current condition of shoreline structures and support the remedial design (RD) for the sediments at the Site. The intent of the pre-design investigation is to collect all data required to address the identified data gaps in a single field sampling event. Coordination on access to the upland and shoreline sampling areas will be made with the Port of Seattle (Port). Surface and subsurface samples will be collected to evaluate the chemical and geotechnical/physical characteristics of the sediment. These samples will be analyzed for chemicals of concern, geotechnical properties and physical characteristics and will also be used for dewatering tests (Figure 7-1 and Table 7-1). In addition, samples and data will be collected to evaluate the sheet pile wall shoreline structures. The primary task that will be completed for this project is sediment sample collection and analysis. Sediment core samples will be collected using sonic drilling, hollow-stem auger, or vibracore technique. Surface sediment samples will be collected using a Van Veen grab sampler or equivalent. Samples will be analyzed for project-specific parameters to evaluate the chemical, geotechnical and physical characteristics of the Site. The chemical parameters of interest for sediment samples include polychlorinated biphenyl (PCB) Aroclors, polycyclic aromatic hydrocarbons (PAHs), pentachlorphenol bis(2-ethylhexyl)phthalate, metals, total organic carbon (TOC), and tributyltin. Samples will not be collected for the analysis of dioxins and furans during the pre-design investigation. Sampling for dioxins and furans will be considered as part of the post-remediation work. Physical parameters of interest include moisture content, specific gravity, Atterberg Limits, and grain size.

Geotechnical data will be collected using Cone Penetration Tests (CPT) including seismic CPTs, Field Vane Tests (FVT), and core sampling for geotechnical laboratory analyses (grain size, Atterberg limits, moisture content).

7.1 CHEMICAL CHARACTERIZATION

Sediment samples are proposed to address several data gaps in contaminant characterization at the Site (Table 7-1). Sampling locations required to address these data gaps are shown in Figure 7-1.

7.1.1 Intertidal Sediment Samples

Two sets of intertidal sediment samples will be collected, one set specifically targets the intertidal area, and the second set targets the shoreline.

- 8 intertidal cores to a depth of 5 feet sampled in five 1-foot increments
- 6 shoreline cores to a depth of 15 feet sampled in fifteen 1-foot increments

A total of eight cores will be collected in the intertidal area (between -10 and 4 feet mean lower low water [MLLW]). Cores will be approximately 5 feet long to determine the depth of removal required in the intertidal area that is currently assumed to have 3 feet proposed for removal and backfill. Each sample will consist of 1-foot intervals for a total of five samples per core. Forty intertidal samples will be collected, but only 24 of these samples (upper three sampling intervals) and additional samples from deeper where there are visual material changes (e.g., sand to silt) in the core, if present, will be analyzed initially for chemical parameters. Results will be evaluated and additional samples will be analyzed if levels of contaminants of concern (COC) are found to be greater than cleanup criteria at a certain depth. Samples from greater depths at the same sampling location will be analyzed to define the extent of exceedances.

A total of six locations will be drilled on the shoreline to a depth of 15 feet and sampled in 1-foot increments for a total of 15 samples per location. Ninety intertidal samples will be collected, of which 24 samples (upper four 1-foot intervals) will be analyzed initially for chemical parameters. Results will be evaluated and additional samples will be analyzed if levels of COCs are found to be greater than cleanup criteria at a certain depth. Samples from greater depths at the same sampling location will be analyzed to define the extent of exceedances. Table 7-2 identifies the sample analysis plan for chemistry analysis.

7.1.2 Subtidal Sediment Samples

Six areas will be sampled to identify the extent of chemical contamination in the subtidal zone.

- Six shipway cores to a depth of 10 feet or refusal sampled in ten 1-foot increments.
- Two shipway above concrete apron cores to a depth of 3 feet or refusal composited into one sample. The concrete apron is part of the Shipway and is adjacent to the bulkhead. Sediment has accumulated on top of the apron.
- Four dry dock cores to a depth of 20 feet sampled in twenty 1-foot increments.
- One dry dock core to a depth of 5 feet sampled in five 1-foot increments.
- Five re-verification cores to a depth of 10 feet sampled in ten 1-foot increments.
- Two re-verification cores to a depth of 5 feet sampling in five 1-foot increments at surface sample only locations with potential for dredging.
- Eight surface grab samples to delineate the areal extent of contamination above action levels requiring dredging in the isolated removal areas. Three of the locations will be held as step outs to be analyzed based on the results of the initial five samples.
- Six borings in the mounded areas under the piers to 15 feet with collection of fifteen 1-foot increments.

The cores will be analyzed in phases, with the initial sample results evaluated before analyzing additional samples to determine the extent of contamination. A total of 78 samples will be analyzed for the full suite listed in Table 7-2. The remaining sample increments will be archived and only analyzed if needed. Specifically, if levels of COCs are all found to be less than cleanup criteria at a certain depth, samples from greater depths at the same sampling location will not be analyzed.

7.2 DEWATERING OF SEDIMENT

Sample composites will be collected from four locations within each of three areas for the full depth of sediment to be removed. The three areas are Dry Dock 1, Dry Docks 2 and 3, and the shipway. Each composite sample consists of approximately 10 gallons of sediment to be analyzed to determine dewatering characteristics of sediment. During dewatering testing, Site sediment and Site water will be used to simulate conditions during mechanical dredging. Solids concentration

(% dry weight) and unit weight of each sample will be determined. Sediment samples from the water column in the containers will be removed and mixed with selected amendments at certain percentages. Total suspended solids (TSS) of the water released from each sample will be measured. Solid concentration, unit weight and paint filter tests will be performed on sediment mixed with amendments (Table 7-3).

7.3 GEOTECHNICAL DATA

Geotechnical information will be collected for the geotechnical slope stability analyses and structural stability evaluations. The geotechnical investigation includes CPT, FVT, geotechnical borings, and a physical survey.

7.3.1 Geotechnical Exploration Plan

The primary objective of this exploration plan is to obtain information for post-dredging stability analyses of the shoreline slopes and sheet pilings. The proposed plan covers data gaps and complements existing geotechnical data provided in previous reports. Locations for the upland geotechnical borings were selected to provide pairing with off shore geotechnical locations and to be near historic Hart Crowser geotechnical borings to allow for correlation of CPT and geotechnical data with Standard Penetration Test (SPT) and lithology data.

The proposed sampling includes the following:

- Five upland geotechnical borings to 20 feet below ground surface (bgs)
- Five upland CPTs to approximately -75 feet MLLW (60 feet bgs). Three upland CPTs will include seismic testing to approximately -100 feet MLLW (85 feet bgs).
- Eight offshore geotechnical borings to 20 feet below the sediment surface
- Four offshore CPTs to approximately -75 feet MLLW (50 feet below sediment surface).
- Eight offshore locations where FVT will be tested to 25 feet below the sediment surface at depths where fine-grain deposit (silt and clay) is found
- A physical survey of the bank to investigate the depth of the toe of the riprap, integrity of existing structures, and slope stability

The proposed locations are shown in Figure 7-1. The proposed locations are approximate and may be adjusted slightly if there are physical obstacles at the intended sampling location.

CPT will provide a continuous Site stratigraphy with piezometric data and geotechnical design parameters. Seismic CPT provides a profile of shear wave velocity that can be used in site response analysis to perform seismic stability analysis. CPT typically has superior accuracy and precision compared to typical drilling and testing, predicts many design parameters normally obtained by traditional drilling and sample testing, and does not generate drilling spoils. Geotechnical design parameters along the boring (e.g. shear strength, friction angle, equivalent SPT N-value, shear velocity, consolidation parameters, total density, relative density, void ratio, coefficient of lateral stress, sensitivity, fines content) will be obtained either directly through *in situ* tip resistance and sleeve friction measurements or using well-established correlations. CPT is a relatively fast method for *in situ* geotechnical investigations and alleviates issues related to sample disturbance and reconstituting specimens, especially in very soft deposits. The CPT tests are proposed as pairs at upland and offshore locations to establish cross-sections and profiles.

FVTs are proposed to obtain a direct indication of shear strength data within the top 255 feet of fine-grained deposits. These tests will provide information to calibrate the CPT correlations and verify *in situ* strength parameters. FVTs will be performed only at locations appropriate for strength testing (i.e., fine-grained stratum identified by the CPTs).

Geotechnical borings will be conducted using either a sonic or a hollow-stem auger with split spoon sampling to obtain gradation (grain size analysis with hydrometer), moisture content, and Atterberg Limits (liquid and plastic limits) within the top 20 feet. The FVT can be performed combined with these drilling methods. The proposed laboratory testing is included in Table 7-4. If potential contamination in the upland cores is detected by visual observations, the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), and the Port will be notified. No samples for chemical analyses will be collected.

A contingency plan will be in place should obstructions (boulders, etc.) be encountered within the fill materials that would prevent the CPT or drilling to advance to the target depths. Drill-out of obstructions by ODEX (proprietary drilling system) or Sonic methods or restarting the holes at a new location may be required.

7.3.2 Shoreline Investigation

The stability of the bank and depth of the toe of the riprap along the shoreline will be assessed with a physical survey along the shoreline during low tide. No sediment samples will be collected for this assessment. The depth of the riprap will be evaluated by sticking a pole through it and measuring the depth to sediment surface. Locations and depth measurements will be collected using a Trimble global positioning system (GPS) unit to quantify the depth at each location. Measurements will be collected every 50 feet along the shoreline. Photographs and notes will be taken at each location.

7.4 STRUCTURAL ASSESSMENT

Quantitative structural evaluations will be required to determine the condition and load rating of the sheet pile bulkhead walls and to assess how these structures may be affected by dredging.

The following evaluation framework is proposed:

- Determine potential modes of failure and the consequence of failure of sheet pile bulkhead walls (risks)
- Set performance criteria and acceptable safety margin
- Review as-built information and identify information gaps
- Carry out field inspection and testing to collect necessary data where information gaps exist
- Carry out field inspection and testing to determine the existing condition
- Perform structural assessment to estimate the safety margin prior to dredging
- Perform structural assessment to estimate the safety margin after dredging
- Where information gaps remain and structural assessment cannot be completed, discuss impact and alternative path forward

The assessment of the sheet pile walls will account for how dredging may affect the above modes of failure of the wall to determine how the risk of failure may increase. Table 7-5 summarizes the draft structural performance criteria developed at this stage of the project. These criteria should be discussed with the stakeholders to determine the acceptable impact level. The criteria may be revised during the design to better suit the project once further details of the work and the soil/structures are obtained and reviewed.

7.4.1 Structural Field Inspection and Testing Plan

To fill the information gaps and to determine the existing condition, the following field investigation and tests will be conducted as field conditions allow:

- Measure dimensions of the sheet pile wall components that do not require excavation.
- Perform ultrasonic thickness measurement on walers (flanges and web) to determine the degree of corrosion.
- Perform ultrasonic thickness measurement on sheet piles to determine the degree of corrosion.
- Perform ultrasonic thickness measurement of the tie rods and tie rod bearing plates to determine the degree of corrosion.
- Cut a coupon of steel from the exposed top of the sheet piles for lab tensile testing to determine the strength of the steel.
- Determine the penetration depth of the sheet piles by field testing using the induction method which requires drilling a cased hole within two feet of the sheet pile wall and lowering an induction sensor through a polyvinyl chloride (PVC) pipe placed in the drilled hole.

7.5 BATHYMETRY SURVEY

In addition to the contaminant characterization data needs, a high-resolution multi-beam bathymetric survey and either physical poling or sub-bottom profiling will be conducted. The combination of these in-water surveys will identify the location of the toe of the riprap along the shoreline for both geotechnical analyses and contaminant characterization. A debris survey will be completed with a sidescan sonar survey of the project area with a 600 kilohertz (kHz) dual-frequency chirp sidescan sonar system to identify debris and a magnetometer survey to detect ferrous metallic objects.

Site mapping, reporting and charting will be completed that meet the following task description.

1) Perform full coverage pre-dredge multi-beam echosounder bathymetry survey of the project area and provide data gridded at 1m or as appropriate for Site water depths,
2) Perform a magnetometer survey of the project area to detect ferrous metallic objects within the survey area.

3) Perform a sidescan sonar survey of the project area with a 600 kHz dual-frequency chirp sidescan sonar system to identify debris that is proud (elevated/exposed above) of the bottom.

4) Prepare a geophysical survey memorandum describing the data collection equipment and process and present the results in three charts containing the following data:

   - Site bathymetry digital terrain model (elevation),
   - Magnetometer data with ferrous targets, and
   - Sidescan mosaic with potential obstructions, debris, and other prominent features.

The survey area will include the Site study area as shown in Figure 5-4. Sidescan and magnetometer surveys will focus on areas where dredging and removal will occur but will include a survey of the entire project area.

Geophysical surveys will be conducted using the following primary equipment or equivalent systems: multi-beam sonar (RESON 7125SV), sidescan sonar (Edgetech 2000-DSS or 4125), and magnetometer (Marine Magnetics Overhauser). Secondary support systems will include a GPS-based position and motion sensor augmented by real-time kinematic corrections capable of achieving 0.01 degree roll and pitch accuracy (i.e., POS MV or comparable) with positional accuracy better than 0.4 foot.

7.6 PRE-DESIGN FIELD SAMPLING DATA REPORT

At the completion of the field sampling, sample analysis, and data validation, a field sampling data report will be compiled and submitted to EPA for review and approval. The field sampling data report will be prepared documenting all activities associated with collection, compositing, and transportation of samples. Contents of the data report are further outlined in the Quality Assurance Project Plan (QAPP) (Appendix B). On EPA's approval of the field sampling data report, the 30 percent design will be initiated.

Legend

- Lockheed West Site
- Harbor Lines
- Pacific Sound Resources Marine Sediment Unit (approximate)
- West Waterway OU (approximate)
- RA5 - Former Shipyard Uplands
- Removal to CSL in Dry Dock Areas
- Dredge to SQS in West Waterway Navigation Channel
- Removal to SQS in Shoreline/Intertidal and Former Shipway Areas
- ENR to Study Area Boundary
- Former Dry Dock Areas
- Habitat Mix
- Riprap Armor Stabilization
- Backfill to Existing Elevations
- Habitat Softening/Enhancement in Existing Riprap Areas
- Remnant Piling Areas (Other Small Areas of Remnant Piling are Excluded)

2007 and Earlier Sampling Locations

- Intertidal Surface Grab
- Subsurface Core
- Surface Grab
- Geotechnical Boring

Proposed Sampling

- Cores to Determine the Volume of Sediment to Remove in the Shipway Piers
- Cores to Refusal to Determine if Accumulated Sediment on the Concrete of the Shipway Requires Removal
- Cores to Determine the Amount of Sediment to be Removed Under the Footprint of the Former Piers
- Cores to Determine the Depth of Removal Required in the Intertidal Area (-10 to 4 feet MLLW)
- Cores to Determine the Depth of Removal Required Along the Shoreline
- Cores to Revisit Prior Sampling Locations to Determine the Depth of Contamination Where Not Achieved and Confirm Presence and Depth of Contamination at Locations with Surface Samples Only
- Core Sample for Geotechnical Testing and Field Vane Test
- Core Sample for Geotechnical Testing and Cone Penetration Test
- Core Sample for Geotechnical Testing and Seismic Cone Penetration Te
- Core Location for Lithology and Geotechnical Test Parameters, Cone Penetration Test and Field Vane Test
- Surface Sediment Grab Sample
- Surface Sediment Grab Sample (for Hold)
- Core Sample for Dewatering Testing

AC = Acre
CSL = Cleanup Screening Level
CY = Cubic Yard
ENR = Enhanced Natural Recovery
SQS = Sediment Quality Standard

0 125 250 500 Feet

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Lockheed West Site
Seattle, WA

Figure 7-1: Pre-Design Sampling Outline

Preferred Alternative - 3C Plus, Pre-1998, 2003 and 2007 Sampling Locations

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Table 7-1 Pre-Design Investigation Sampling Program

Objective for Sampling		Target Areas (Figure 7-1 symbol)	Details on sampling locations	Rationale for sampling	# cores	Target Core Depth (ft)	# intervals / core	# intervals analyzed/core (Initial)	Basis of interval analysis selection	Total samples for initial analysis	Total samples collected (approx)
Chemical Characterization	Determine depth of removal required in the Shipway	Shipway	6 cores located within the area of pilings	full analysis to determine the depth of removal required to meet ROD objectives for removal and backfill in the shipway	6	10 (refusal)	10	3	Surface (0-0.5), above material change, below material change or middle of core and botttom of core where no change	18	60
		Shipway above concrete	2 cores to refusal to determine if material accumulated on the concrete is contaminated and requires removal. Additional probing to determine depth and volume of material present	Sampling to determine if material on the concrete area at the south end of the shipway requires removal for contamination.	2	3 (Refusal)	1	1	Composite of full depth of sediment recovered	2	2
	Determine the depth of contamination at locations where RI data did not define a bottom	Dry Docks	3 cores (TT07, TT08, TT18) targeting locations from RI where depth of contamination not defined.	full analysis to determine the depth of removal in the dry docks where RI data did not find a "clean" interval.	3	20	20	4	Surface (0-0.5), 1 additional sample interval above or at the target elevation and 2 sample intervals below the target elevation. Target elevation = elevation reached with the RI core with contamination above the action level (no bottom of contamination found).	12	60
			1 core (TT-30) targeting locations from RI where depth of contamination not defined.	full analysis to determine the depth of removal in the dry docks where RI data did not find a "clean" interval.	1	5	5	4		4	5
	Re-visit locations to confirm previously collected data for small pockets of removal identified in the FS	Various	5 cores (TT20, Ecology 197, TT04, TT34(2)) to verifiy and replace prior data where currently pocket removal is proposed.	Sampling to confirm presence of contamination above action level concentrations and at depths that require removal.	5	10	10	3	Surface (0-0.5), (1-2), (2-3)	15	50
	Delineate area of elevated contamination around small pockets of dredging	Various	Surface samples around locations TT20 (2) and Ecoloy 197 (3)	Sample to determine the areal extent of concentrations above the action levels around isolated location-based dredge areas. Removal depths across the lateral extent of contamination determined by the surface samples would be based on cores within the isolated dredge areas.	5	0.5	1	1	Collection of surface sample (0 - 0.5)	5	5
	Step out samples to delineate area of elevated contamination around small pockets of dredging	Various	Step out surface samples around locations TT111, TT113, TT114, TT115 and TT117	Sample to determine the areal extent of concentrations above the action levels if locations TT111, TT113, TT114, TT115 and TT117 have concentrations above action levels	3	0.5	1	1	Collection of surface sample (0 - 0.5)	0	3
	Define extent of contamination in former pier areas	Mounded areas under the former piers	6 borings to determine the vertical extent of contamination to be removed in the mounded sediment under the old piers (Pier 21, Pier 22 and outer edge dry dock 1)	Determine the depth of removal required for the mounded sediment under the old pier structures	6	15	15	3	Surface (0-0.5), (1-2), below material change	18	90
	Determine depth of contamination and removal in the intertidal areas (between -10 and 4 ft)	Beach/Intertidal Areas	Cores (8 total); one around 2 ft MLLW and one around -2 to -4 ft MLLW to determine the depth of removal required in the intertidal/bach areas (currently assumed to be 3 ft)	Sampling to determine the extent of contamination in the intertidal areas	8	5	5	3	Surface (0-0.5), (1-2), (2-3)	24	40
	Define extent of contamination into shoreline	Shoreline	7 borings (2 between Pier 24 and Pier 23, 2 in dry docks 2 and 3, 1 one corner ridge between dry docks 1 and 2, 2 near TT07 with one at toe and one recollection TT07 (TT07 accounted for above).	Sampling to determine the extent of contamination that is into the shoreline slope and define the depth of removal along the Shoreline.	6	15	15	4	Surface (0-0.5), (1-2), (2-3), below material change	24	90
Geotechnical Data	Geotechnical sampling	Shoreline of areas to be dredged (Dry Docks)S	8 borings (Hollow-stem auger or Sonic rig for gradation (w/ hydrometer), Moisture Content, Atterberg Limits, Field Vane Test) in subtidal areas near the shoreline	Collect geotechnical samples to evaluate slope stability, structural stability	8	Drill - 20 ft FVT - 25 ft	3	3	Geotech samples every 5 ft (3/location) Field vane - every 3 ft to 25 ft where fine-grained material present	24	24
	Geotechnical investigation	Shoreline of areas to be dredged (Dry Docks)	Cone Penetrometer Test (CPT)	Perform geotechnical investigation to evaluate slope stability, structural stability	4	4 CPT- 50 ft			CPT - continuous profile		
	Geotechnical investigation	Upland area	5 borings (Cone Penetrometer Test, Hollow-stem auger or Sonic rig for gradation [w/ hydrometer], Moisture Content, Atterberg Limits) in the upland area close to the shoreline paired with off-shore borings Seismic Cone Penetrometer Test	Perform geotechnical investigation to evaluate slope stability, structural stability. CPT to the same elevation as off-shore borings.	5	2 CPT ~ 75 ft 3 SCPT ~ 100 ft Drill - 20 ft	3	3	Geotech samples every 5 ft (3/location)	15	15

Table 7-1 Pre-Design Investigation Sampling Program

Objective for Sampling		Target Areas (Figure 7-1 symbol)		Details on sampling locations	Rationale for sampling	# cores	Target Core Depth (ft)	# intervals / core	# intervals analyzed/core (Initial)	Basis of interval analysis selection		Total samples for initial analysis	Total samples collected (approx)
Dewaterability of Sediment	Determine dredge material dewaterability characteristics	Dredge areas		One composite sample from Shipway area, 1 from Dry Docks 2/3 area, and 1 from Dry Dock 1 area	Samples collected at former shipway area, and former pier areas will be used to run dewaterability parameters (water content, in situ % solids, specific gravity, bulk unit weight, organic matter, total suspended solids, paint filter)	12 (4 from 3 areas, shipway from planned)	various - to depth of removal	1	3	Composite of full depth of sediment to be removed. Composite of 2 samples from dry dock 1 area; 2 samples from the dry docks 2/3 area. Cores from former shipway will also be composited for dewaterability in shipway		3	3
Structural Assessment	Sheet pile wall depth	Northeast sheetpile wall		1 boring within 2-4 ft of sheet pile wall to determine embedment depth of sheet piles	Bore hole to perform induction testing to determine embedment depth	1	75 ft	n/a	n/a	Boring depth is based on the known sheet pile burial depths, 2 to 3 times of bank supported height		n/a	n/a
	Sheet pile wall structural integrity/stability	Two sheet pile walls on shoreline		One sheet pile coupon at each sheet pile wall	Collect data to evaluate current conditions of two sheet pile walls at the shipway and near the northeast corner of the site including corrosion and thickness testing and tensile strength of coupon samples	2- test samples	n/a	n/a	n/a	Sheet pile copons are priority. Tie rod and waler sections will be cut if available		2 - steel samples	2 - steel samples

Table 7-2
Chemistry Laboratory Testing for Intertidal Samples

Test	Method	Number of Initial Analyses for Intertidal and Shoreline[1]	Number of Initial Analyses for Subtidal Cores[2], borings, and surface samples
PAHs	EPA Method 8270C -low level	48	78
SVOCs pentachlorophenol & bis(2-ethylhexyl)phthalate	EPA Method 8270C	48	78
PCBs	EPA Method 8082	48	78
Metals	EPA Methods 6020/6010B	48	78
Mercury	EPA Method 7471A	48	78
Tributyltin	Krone 1989	48	78
Total Organic Carbon	Lloyd Kahn	48	78
Total Solids	ASTM D2216	48	78
Sieve Analysis with Hydrometer	ASTM D422	48	78

[1] 1-ft increments with three samples analyzed per intertidal core and 4 samples analyzed per shoreline boring.
[2] 1-ft increments for all locations except for composites in the 2 cores located in the shipway above the concrete.

Table 7-3
Dewatering Tests

Test	Method	Number of Analyses
Moisture content	ASTM D2216	3[1]
Organic matter	ASTM D2974-14	3[1]
Specific gravity	ASTM D854	3[1]
Unit weight	ASTM D7263-09	9[2]
Percent solids	EPA Method 160.3	9[2]
Total suspended solids	EPA Method 160.2	9[2]
Paint filter test	EPA Method 9095B	9[2]
Moisture content	ASTM D2216	3[2]

[1] 3 samples from Dry Dock 1, Dry Docks 2 and 3, and shipway
[2] Number of tests may change based on number of amendment testing

Table 7-4
Geotechnical Laboratory Testing

Test	Method	Number of Analyses
Sieve Analysis with Hydrometer	ASTM D422	39[1]
Atterberg Limits	ASTM D4318	39[1]
Moisture content	ASTM D2216	39[1]

[1] Three per core at 5-foot intervals within the top 20 feet

Table 7-5
Performance Criteria

Impact Level	Short Term (during dredging or timber pile removal)		Long Term		
	Impact/Damage	Mitigation Strategy	Impact/Damage	Mitigation Strategy	Target Geotech FoS
Minimal	▪ No pavement cracking ▪ Sheet pile structural FoS >= 2 for combined bending and axial load[1] ▪ Sheet pile structural FoS >= 3 for shear[1]	▪ Keep away ▪ Install new sheet pile wall or new retaining structure	▪ Same as short term ▪ Sheet pile structural FoS >= 2 for combined bending and axial load ▪ Sheet pile structural FoS >= 3 for shear	▪ Keep well away from zone of influence ▪ Backfill ▪ Install new sheet pile wall or new retaining structure	FoS > 1.5
Moderate	▪ Multiple pavement cracks up to 50 mm ▪ Sheet pile structural 1.5< FoS< 2 for combined bending and axial load ▪ Sheet pile structural 2.3<FoS< 3 for shear	▪ Observational ▪ Keep well away from zone of influence ▪ Flat side slopes ▪ Strengthen existing wall ▪ Install new sheet pile wall or new retaining structure	▪ Cracking with time ▪ Sheet pile structural 1.5< FoS< 2 for combined bending and axial load ▪ Sheet pile structural 2.3<FoS< 3 for shear	▪ Keep away ▪ Backfill ▪ Flat side slopes ▪ Strengthen existing wall ▪ Install new sheet pile wall or new retaining structure	FoS > 1.3
Significant	▪ Possible collapse	▪ Do Nothing, keep well away from zone of influence			FoS < 1.3
Seismic	Not considered				

[1] Factor of Safety (FoS) based on USACE Design of Sheet Pile Walls document.

Section 8
Remedial Design Activities

Remedial design activities include the completion of all planning activities and deliverables associated with preparing for implementation of the remedy as set forth in Section X and Paragraph 30.a (remedial design) of the Unilateral Administrative Order (UAO) and Sections IV. B (remedial design) of the Statement of Work (SOW), Appendix B to the UAO (U.S. Environmental Protection Agency [EPA] Docket No. 10-2015-0079/Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]) for the Remedial Design and Remedial Action for the Lockheed West Seattle Superfund Site (Site).

The goal of remedial design is to develop a technical package (or packages) that contains or addresses all the elements necessary to fully accomplish the remedy selected by EPA in the Lockheed West Seattle Record of Decision (ROD) (EPA, 2013) and as outlined in the SOW (EPA, 2015c). EPA selected a remedy comprising the following elements to address contaminated sediment at the Site:

- Debris and piling removal (and disposal)
- Bank evaluation
- Sediment removal and disposal
- Intertidal backfill placement
- Enhanced natural recovery (ENR) layer and dredge residuals management layer placement
- Institutional controls
- Long-term monitoring and maintenance

The remedial design will include all information necessary to:

- Obtain and manage a qualified contractor for implementation of the remedy.
- Ensure that the remedy as designed will meet all applicable or relevant and appropriate requirements (ARARs) and the requirements set forth in the UAO/SOW, ROD and associated Explanation of Significant Differences (ESD) (EPA, 2015a).
- Demonstrate the feasibility of all components of the remedy.

- Demonstrate the use of standard professional engineering practices.
- Provide for contingency planning in the event of failure of any aspect of the remedy during and after implementation.
- Conduct operations, maintenance, and monitoring.
- Document all phases of work.

8.1 REMEDIAL DESIGN COMPONENTS

Design components will include the following:

- Remedy design assumptions, parameters, design considerations and objectives
- Debris, riprap, pilings removal along the shoreline and shipway
- Shoreline/intertidal area excavation and dredging
- Former shipway area and below -10 feet mean lower low water (MLLW) dredging
- Stability evaluation of shoreline banks, structures during excavation and dredging
- Dredge residuals management layer and ENR layer placement
- Technical approach for sediment removal, handling, dewatering, transportation, and disposal
- ENR layer material selection approach and placement methodology
- Methodology for verification of cleanup goals, and long-term monitoring elements
- Design plans, drawings
- Design specifications, and
- Design calculations

8.2 REMEDIAL DESIGN PHASES

Design deliverables will be submitted as Preliminary (30%), Intermediate (if necessary), Pre-Final (90%), and Final (100%) design submittals. Lockheed Martin’s contracting strategy includes developing the design to the 30% level and then soliciting a design/build procurement where the successful bidder would complete the development of the design and then implement the remedial action. However, Lockheed Martin reserves the right to implement the selected remedy as a single combined design/construction contract or as separate design and construction contracts.

8.2.1 Preliminary (30 Percent) Design

The objectives are to advance the sediment remedy design from the conceptual level presented in the Feasibility Study (FS) to 30% design based on the findings from the field sampling and analysis, identify the best available technologies and approaches to be carried forward in to further stages of design, incorporate approaches that are responsive to regulatory agency and stakeholder issues and to provide a 30% design document for the subsequent design/build procurement.

Tetra Tech will utilize the pre-design field investigation data report in development of the Preliminary (30%) Design package. Debris, bulkheads, riprap and pilings to be removed as identified during field work will be summarized and shown on the design drawings. Upland disposal locations for debris, bulkheads, riprap, and pilings will be identified. Methods and performance requirements for how excavated and dredged sediment will be removed, handled, dewatered, transported, and disposed will be discussed at a 30% design level. Based on field investigation results, removal depths will be illustrated in design drawings, overcut allowances will be noted. ENR layer placement areas will be illustrated. Remedy design quantities will be determined at 30% design level. The Preliminary Design will include and discuss the following:

a. Results of pre-design field sampling and how the results will be utilized in development of the preliminary design package.

b. Preliminary plans and drawings including an outline of required specifications not otherwise provided in detail and a list of all final drawings to be included in pre-final and final design.

c. Design report, with detailed design assumptions, parameters, design restrictions and objectives, including but not limited to:

General Elements:

- Descriptions of the analyses conducted to select the design approach, including a summary and detailed justification of design assumptions
- Construction sequence of debris and pile removal, dredging, backfill, disposal, dredge residual management layer, and ENR layer placement
- Technical parameters and essential supporting calculations (at least one sample calculation presented for each significant or unique design calculation) upon which the design will be based, including but not limited to design requirements for each activity (e.g., removing debris along shoreline, dredging)

- Short-term environmental control measures to reduce impact to the environment during construction
- Access and easement requirements (Port of Seattle [Port] and Washington State Department of Natural Resources [DNR]), including an evaluation of the most appropriate institutional and/or proprietary controls for each element of the remedial action to ensure long- term effectiveness
- Coordination of Lockheed Martin's remedial activities with other in-water work, treaty-protected uses (Muckleshoot Indian Tribe and Suquamish Tribe), navigation and commerce, property owners (i.e., Porte and State of Washington managed by DNR)
- Protocol for archaeological monitoring and discovery during construction
- Permit requirements or substantive requirements of permits
- Preliminary construction schedule, including contracting strategy
- Plans and protocols for pulling pilings and/or placing ENR layer around pilings and other structures

Debris, Riprap, Pilings Removal Elements:

- Debris, bulkheads, riprap and pilings to be removed will be summarized and shown on the design drawings
- Geotechnical analysis demonstrating bank stability after removal of debris, bulkheads, riprap and pilings will be provided
- Identify upland disposal locations for debris, bulkheads, riprap, and pilings

Excavation and Dredging Elements:

- Methods and requirements for how excavated and dredged sediment will be removed, handled, dewatered, transported, and disposed of
- Sediment excavation prism verification
- Design removal depths and overcut allowances
- Refinement of material volumes and removal techniques
- Analysis of excavations and dredge cuts to ensure contaminated side slopes do not remain exposed after removal
- Structural analysis of shoreline structures (sheet pile walls) during excavation and dredging. Present mitigation approach if the results show reduced safety margin against failure of sheet pile walls
- Backfill of the bank and intertidal area
- Identification of upland landfill location for disposal of dredged sediments

- Method and location for dewatering dredged sediment disposed of upland and disposal of associated water

ENR Layer/Dredge Residuals Management Layer Elements:

- Appropriate physical and chemical characteristics of materials to be used for sediment ENR layer and dredge residuals management layer
- Selection of ENR layer material and dredge residuals management layer material suitable for colonization by aquatic organisms
- Method for identifying and testing clean source materials, including acceptance criteria for such sediment
- ENR layer and dredged management residual layer placement techniques
- Slope stability analysis to evaluate the ENR layer application
- ENR placement calculations for clean material over underlying sediments with contaminant concentrations greater than Cleanup Levels as identified in the UAO/SOW Attachment 3. This calculation will include both point-based and surface weighted averages

Verification and Long-Term Monitoring Elements:

- Description/outline of proposed cleanup verification methods for remedial action construction, including compliance with ARARs that will be addressed in Construction Quality Assurance Plan (CQAP) and Long-term Monitoring and Maintenance Plan (LTMMP). The verification methods for meeting the Remedial Action Levels in dredging areas, as well as verification of the ENR/dredge residual management layer are critical for establishing when Lockheed Martin has met the criteria for completing construction. Methodology to determine the conclusion of the CQAP activities and beginning of LTMMP activities will be discussed.

Specific engineering activities to develop the Preliminary (30% Design) Design package are summarized below.

Coastal Engineering:

The coastal engineering team will identify tidal datum, analyze existing wind and wave forces, and estimate a design wave height and period to design shoreline stabilization. The team will explore potential wave load due to typical boating activities at the Site and incorporate into shoreline stabilization design. The coastal engineering team will coordinate with the geotechnical and structural engineering team to support the stability evaluations of existing structures.

Geotechnical Engineering:

The geotechnical engineering team will provide calculations demonstrating bank stability after removal of debris, bulkheads, riprap and pilings. Geo-Slope SLOPE/W software for conventional two dimensional limit-equilibrium slope stability analyses will be used for slope stability analyses. Soil units and strength parameters will be assigned based on the results of the pre-design geotechnical investigation. The analysis will be applied at key locations along the alignment of dredging. Slope stability analysis will include evaluation of submerged slopes in dry dock areas to minimize sloughing during dredging.

Structural Engineering:

The structural engineering team will coordinate with the geotechnical engineering team and utilize findings of geotechnical analyses to assess the stability of shoreline structures. Structural field inspection and testing results will be used to determine as built geometry, material properties, current loading, current conditions and deterioration of the structures. Structural assessment will be performed and reduced safety margin against failure of the sheet pile walls when the sediment at the seaward side of the sheet pile is dredged will be determined. The acceptability of a reduced safety margin will be discussed based on the performance criteria that will be developed during design. Mitigation measures will be recommended based on the analyses.

Design Calculations:

A set of engineering calculations will be developed at a 30% design level to support the remedial design. Technical parameters (i.e., coastal, geotechnical) and essential supporting calculations will be presented. Calculation packages will include tidal datum, design wave height and period to support shoreline stabilization, remedy construction quantity estimates (dredge volume, ENR, residual management volume, debris, dewatering volume), and shoreline and dredge slope stability during shoreline excavation and dredging. Preliminary design calculations will be developed at a 30% level to support the remediation design and provide documentation for the subsequent design/build procurement. It is anticipated that some of the engineering calculations such as dredging and excavation volumes and engineering parameters will be developed at a more advanced level than the 30% design because the pre-design investigations will provide sufficient details to advance these calculations.

8.2.2 Intermediate (60 Percent) Design

If approved by the EPA, Intermediate Design Deliverables will be submitted in the form of agreed-upon deliverables or technical memoranda to facilitate the efficient review and approval of the final remedial design by the EPA. Intermediate Design Deliverables may include a draft CQAP, draft LTMMP, draft Quality Assurance Project Plan (QAPP)/Field Sampling Plan (FSP) for remedial action construction, or may address other specific technical or design issues. Any remedial design data not available for submission as part of the Preliminary (30%) Design will be submitted as an intermediate design deliverable.

If submitted, the Intermediate Design may include or discuss the following:

a. Results of additional field sampling.

b. Incorporate revisions to 30% design based on comments received from EPA.

c. Plans, drawings, and sketches, including an outline of required specifications not otherwise provided in detail and a list of all final drawings to be included in pre-final and final design documents.

d. Design assumptions, parameters, design restrictions and objectives for riprap/concrete/bulkhead and pile removal and replacement, excavation, dredging ENR and dredge residual management layer.

More information about the expected content of the CQAP, LTMMP and other plans associated with remedial action design and construction is provided below.

8.2.3 Pre-Final (90 Percent) and Final (100 Percent) Design

Pre-final Design will be submitted when the design effort is ninety percent (90%) complete and the Final Design will be submitted when the design effort is one hundred percent (100%) complete. The Pre-final Design will fully address all comments made to the preceding design submittal(s). The Final Design will fully address all comments made to the Pre-final Design and will include reproducible drawings and specifications.

The Pre-final and Final Design submittals will include those elements listed for the Preliminary Design, as well as the following (unless previously submitted as an Interim Design Element approved by the EPA):

a. Final plans and specifications

b. Draft CQAP

c. Draft Water Quality Monitoring Plan

d. Draft QAPP/Health and Safety Plan (HASP)/FSP for remedial action construction activities

e. Draft Permitting and Site Access Plan

f. Draft Site Management Plan (includes Contingency Plan, Pollution Control Plan, Transportation and Disposal Plan, Green and Sustainable Remediation Plan, and Climate Change Adaptation Site Plan)

g. Draft Institutional Control Implementation and Assurance Plan (ICIAP)

h. Draft LTMMP

i. Draft Biological Assessment.

j. Draft Capital and Operation and Maintenance Cost Estimate

k. Final Construction Project Schedule

l. Any additional plans identified in the Remedial Design Work Plan (RDWP)

8.2.4 Construction Drawings and Specifications

Construction drawings and specifications will conform to standard engineering practice and will demonstrate that the technical requirements of the project are being addressed sufficiently to result in a remedial action that is implementable and effective. Specifications will conform to Construction Specifications Institute (CSI) format and will include a submittal log identifying all plans, documents, and construction items submitted by contractors during the remedial action. Remedial construction drawings will include, but not be limited to the following list:

- Project datum, construction notes, construction sequencing
- Current bathymetry map with debris survey
- Areal of design overview
- Existing conditions with aerials, photographs
- Access, staging, haul route

- Temporary erosion and sediment control plan, notes, details
- Shoreline remedy plans (shoreline material and debris, remediation and fill placement along shoreline inclusive of photographs)
- Shipway area remediation plans (demolition of piling and dredging plan, cross-sections);
- Dredge plan, prism, cross-sections, profiles
- Areal drawings for areas of ENR placement
- Water quality monitoring plan
- Sediment handling plan
- Best management practices and details

The level of detail in the construction drawings and specifications will be consistent with the stage of the design process. Drawings submitted as Preliminary Design deliverables will reflect at least 30% completion of the design effort. The Pre-Final Design deliverables will reflect completion of at least 90% of the design effort and will incorporate all changes, corrections, or additions required by EPA in its review of the Preliminary Design deliverables. An outline of the draft design specifications will be provided at 30% design, will be drafted at 60% design, and finalized at 90% and 100% design submittals. Technical specifications developed at 30% design level will identify specific requirement to achieve the cleanup goals and performance requirements for construction, but will provide flexibility to the design/build contractor to advance the design and refine the means and methods of construction to accomplish the work.

8.2.5 Construction Project Schedule

A project schedule for the construction and implementation of the remedial action that identifies timing for initiation and completion of all critical path tasks will be submitted as part of the Final Design. The project schedule will include specific dates for major milestones and completion of the project. The project schedule will address the remedial activities and all other relevant factors that could impact scheduling such as commerce in this vicinity, coordination with any known development projects anticipated on or near bank and intertidal or subtidal areas, fish windows, and/or Tribal treaty-protected fishing rights.

8.2.6 Draft Capital and Operation and Maintenance Cost Estimate

The Pre-final (90%) and Final Design (100%) submittals will include an updated cost estimate for completion of remedial action and long-term maintenance and monitoring. This cost estimate will refine the feasibility study cost estimate to reflect the detail presented in the Final Design, with an accuracy of plus 15 percent and minus 10 percent. EPA's cost estimating guidance, *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 540-R-D0-002, Office of Solid Waste and Emergency Response [OSWER] No. 9355.0-75, July 2000), will be utilized.

8.2.7 Other Remedial Design Documents in Pre-final and Final Design

The Pre-final (90%) and Final (100%) Design submittals will include the following plans.

8.2.7.1 Draft Construction Quality Assurance Plan

The CQAP describes the Site-specific components of the performance methods and quality assurance program which shall ensure that the completed project meets or exceeds all performance standards and design criteria, plans, and specifications, including achievement of Cleanup Levels.

The CQAP will contain, at a minimum, the following elements:

- Responsibilities and authorities of all organizations and key personnel involved in the design and construction of the remedial action, including the EPA and other agencies.
- Qualifications of the Construction Quality Assurance (CQA) Official, including the minimum training and experience of the CQA Officer and supporting inspection personnel.
- A description of all performance standards and methods necessary to ensure implementation of the remedial action construction, in compliance with ARARs and identified site-specific performance standards. Performance monitoring requirements will be stated to demonstrate that best management practices have been implemented for dredging operations, transportation or dredged material, and proper cap placement techniques.
- The observations and tests required to monitor the construction and/or installation of the components of the remedial action. The plan will include the scope and frequency of each type of inspection to be conducted. Inspections will be required to measure compliance with environmental requirements and ensure compliance with all health and safety procedures.
- Requirements for quality assurance sampling activities including the sampling protocols, sample size, locations, frequency of testing, acceptance and rejection data sheets, problem identification and corrective measures reports, evaluation reports, acceptance reports, and final documentation.
- Means, methods and performance levels to confirm the completion of the dredging in target removal areas including collection of confirmation sediment samples from the dredge

bottom to evaluate dredge residuals and undisturbed residuals. Contingency actions for dredge areas will be outlined based on confirmation sample results.

- Means and methods to confirm the placement of the ENR layer in Site areas outside of the target dredge areas.
- Reporting requirements for CQA activities will be described in detail in the CQAP. This shall include such items as daily summary reports, inspection data sheets, problem identification and corrective measures reports, design acceptance reports, and final documentation storage. A description of the provisions for final storage of all records consistent with the requirements of the Consent Decree will be included.
- Procedures for processing design changes and securing EPA review and approval of such changes to ensure changes conform to performance standards, ARARs, requirements of this SOW, are consistent with the Cleanup Levels and are protective of human health and the environment.
- Identification of all final CQAP documentation to be submitted to EPA in the Remedial Action Construction Report or Remedial Action Completion Report.

Development of the CQAP will follow applicable elements from the EPA guidance identified in the SOW: *Construction Quality Assurance for Hazardous Waste Land Disposal Facilities* (EPA/530(S) SW-86-301, 1987) and *Quality Assurance and Quality Control for Waste Contaminated Facilities* (EPA/600/R-93/182, 1993).

8.2.7.2 Draft WQMP

The Water Quality Monitoring Plan will detail water quality monitoring requirements to confirm compliance with water quality standards (as defined by substantive requirements of Clean Water Act Section 401 Water Quality Certification) during dredging, ENR placement, bank soil excavation and backfill, dredged material dewatering and loading, removal of pilings, and other potential water disturbances during remedial action construction. The plan will describe the specific water quality monitoring requirements, sampling design and rationale, applicable water quality standards and points of compliance, team organization and responsibilities, sampling schedule, monitoring and sampling methods, data management and reporting, and procedures for responding to water quality exceedances. A QAPP and FSP specific to water quality monitoring, as well as a HASP, will be included in this deliverable. A 401 Memo which identifies the Clean Water Act, S401 substantive water quality requirements for the CERCLA action will be written by the EPA.

8.2.7.3 Draft QAPP/HASP/FSP

Site-specific QAPPs will cover sample analysis and data handling for sampling during all phases of future Site work, including sampling during remedial design, remedial construction, and long-term monitoring. Development of the QAPPs will follow EPA guidance, including: *Requirements for Quality Assurance Project Plans* (QA/R-5) (EPA/240/B-0l/003 March 2001 [Reissued May 2006]); *EPA Quality Manual for Environmental Programs* (EPA CIO 2105-P-01-0, May 2000); *EPA Requirements for Quality Management Plans* (QA/R-2) (EPA/240/B-01/002, March 2001); and *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs* (American National Standard, January 5, 1995).

FSPs will describe sample collection activities associated with each QAPP. The FSP will supplement the QAPP and contain all relevant elements described in Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA/540/G-89/004 OSWER Directive 9355.3-01, October 1988).

HASPs will be developed to protect on-site personnel and area residents from physical, chemical, and all other hazards posed by the remedial action and associated sampling activities. The HASPs will follow EPA guidance (*Health and Safety Roles and Responsibilities at Remedial Sites* [EPA OEER 9285.1-02, July 1991]) and all OSHA requirements as outlined in 29 Code of Federal Regulations (CFR) 1910 and 1926. When applicable, existing project HASPs or other company/contractor HASPs may be utilized, modified as necessary to sufficiently address the activities covered by the SOW.

8.2.7.4 Draft Permitting and Site Access Plan

The Permitting and Site Access Plan will demonstrate how the design plans will comply with the permitting requirements identified in this RDWP and shall address any real property and easement requirements. The Plan will provide a strategy and appropriate information for obtaining agreements for access to the Site or associated areas as necessary for the implementation of the remedial action.

8.2.7.5 Draft Site Management Plan

The Site Management Plan will describe how access, security, contingency procedures, management responsibilities, and waste disposal are to be handled. These additional elements may be incorporated into other deliverables or delivered separately and will include, but not be limited to: (a) Contingency Plan, (b) Pollution Control and Mitigation Plan, (c) Transportation and Disposal Plan, (d) Green and Sustainable Remediation Plan, and (e) Climate Change Adaptation Plan. General descriptions and relevant guidance for these plans are described below.

a) Contingency Plan

The Contingency Plan is intended to protect the local affected population in the event of an accident or emergency and will contain the following elements:

- Name of person responsible for responding in the event of an emergency incident;
- Plan and date for meeting with the local community, including local, State, and Federal agencies involved in the cleanup, as well as local emergency squads and hospitals;
- First aid and medical information including names of personnel trained in first aid; clearly marked map with the locations of medical facilities; all necessary emergency phone numbers; fire, rescue, local hazardous material teams; and National Emergency Response Team.

b) Pollution Control and Mitigation Plan

The Pollution Control and Mitigation Plan will provide contingency measures for potential spills and discharges from materials handling and/or transportation. It will describe the methods, means, and facilities required to prevent contamination of soil, water, atmosphere, uncontaminated structures, equipment or material from the discharge of wastes due to spills; provide for equipment and personnel to perform emergency measures required to contain any spillage and to remove and properly dispose of any media that become contaminated due to spillage; and provide for equipment and personnel to perform decontamination measures that may be required to remove spillage from previously uncontaminated structures, equipment, or material.

c) Transportation and Disposal Plan

The Transportation and Disposal plan will describe the procedures to be followed in transporting sediment and debris removed from the Site to the selected upland disposal facility. The plan will include descriptions of the waste materials to be transported, the destinations of the wastes, transportation means and routing, on-site traffic control and loading procedures, recordkeeping requirements, health and safety considerations, and contingency plans for spills that might occur during handling, loading, and transportation

d) Green and Sustainable Remediation Plan

The Green and Sustainable Remediation Plan will describe sustainable technologies and practices for executing the remedial action. A report will be provided at the end of the project as part of the closeout reports. The five goals of the Green and Sustainable Remediation (GSR) Plan are to:

- Reduce total energy use and increase the percentage of renewable energy
- Reduce air pollutants and greenhouse gas emissions
- Reduce water use and negative impacts on water resources
- Improve materials management and waste reduction efforts
- Protect land and ecosystems

The GSR metrics will include “materials and waste,” “water,” “energy,” “air,” and “land and ecosystem.” The methods to track GSR performance will also be identified. Use of local materials, facilities, and environmentally sustainable business practices will also be incorporated.

The GSR Plan will contain all relevant elements described in EPA’s *Methodology for Understanding and Reducing a Projects Environmental Footprint* (EPA/542/R12/002 OSWER and OSRTI Directive, February 2012).

e) Climate Change Adaptation Plan

The EPA is in the process of developing policies and guidelines for implementation of climate change adaptation protocols to ensure continuing protectiveness of current and future remedies. There is no current guidance detailing the expected content of Climate Change Adaptation Plans. The Plan will be developed based on the most recent information available at the time from EPA (http://epa.gov/climatechange/impacts-adaptation/fed-programs/EPA-impl-plans.html).

8.2.7.6 Draft Institutional Controls Implementation and Assurance Plan

The ICIAP will establish and document the activities associated with implementing and ensuring the long-term stewardship of ICs and to specify the persons and/or organizations that will be responsible for conducting these activities. The details of how the Uniform Environmental Covenant Act covenant and the Elliott Bay fish consumption advisory will be specifically implemented, maintained, enforced, modified, and terminated (if applicable) at the Site will also be included. Development of the ICIAP will follow EPA guidance: *A Guide to Preparing*

Institutional Control Implementation and Assurance Plans at Contaminated Sites (OSWER 9200.0-77, EPA-540-R-09-002, December 2012).

8.2.7.7 Draft Long-term Monitoring and Maintenance Plan

The post-remedial action LTMMP and QAPP (or amendments to the remedial design QAPP) will be developed to cover implementation and maintenance and monitoring of the remedial action. Since recontamination of the sediment surface from off-site sources may occur due to ambient conditions in Elliott Bay and the LDW, sampling and numeric performance standards such as Cleanup Levels will not be the only criteria for evaluating the performance of the remedy. Sampling methodology will be developed to evaluate surface sediment recontamination from off-site sources (“top-down” contamination) and to evaluate potential mixing of the clean surface sediment layer with underlying sediment that has contaminant concentrations greater than the Cleanup Levels (“bottom-up” contamination). The sampling will take place in the biologically active zone of the subtidal (10 cm) and intertidal (45 cm) zones. If sampling demonstrates that “top-down” contamination has occurred and commensurately, “bottom-up” contamination has not occurred, and concentrations in the sediment surface layer exceed Cleanup Levels, then sediment quality monitoring will be discontinued.

The LTMMP will include:

- Means and methods to assess the Cleanup Levels in the biologically active zones of the intertidal and subtidal portions of the Site.
- Means and methods for sampling in the ENR layer and dredge residuals management areas to ascertain the effectiveness of these remedial actions.
- Procedures for measuring and documenting if recontamination, if occurring, is from off-site sources (“top-down” contamination).
- Means and methods for evaluation of the bank excavation and replacement areas and areas of fish mix placement.
- Definition of triggering weather and/or seismic events that will require monitoring and/or sampling after they occur.
- Identification of monitoring measures that will be taken after a triggering weather and/or seismic events.
- Metrics and schedule for demonstrating successful implementation of the remedy and reductions in monitoring to trigger events.

- Identification of monitoring activities, including file reviews and interviews with the landowners pertaining to any development that has occurred at the Site since the remediation was complete in order to support the five-year review.
- Contingency actions to be taken as repairs, supplemental actions or maintenance to maintain the remedy.
- Note: Surface water and fish tissue samples will not be collected as part of the long-term monitoring program or for the five-year review.

The LTMMP will evaluate and include, as appropriate and per the schedule to be developed, the following types of monitoring to achieve the monitoring objectives of each element of the remedial action, and will be used to support the EPA Five-Year Review:

- Bathymetry
- Sediment chemistry
- Sediment bioassays, if necessary
- Sediment profile imaging cameras

Development of the LTMMP will follow EPA guidance: *Guidance for Monitoring at Hazardous Waste Sites, Framework for Monitoring Plan Development and Implementation* (OSWER Directive No. 9355.4-28, January 2004); and *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA-540-R-05-012, OSWER 9355.0-85, December 2005).

8.2.7.8 Draft Biological Assessment

A Biological Assessment will be prepared to ensure compliance with the Endangered Species Act (ESA) by identifying the presence of threatened, endangered, proposed, or candidate species, or their habitat within the vicinity of the cleanup action. The Biological Assessment will characterize baseline conditions of the existing habitat, address potential project impacts the remedial action may have on these species, their habitat, and food stocks. The Biological Assessment will also identify best management practices and conservation measures designed to avoid or minimize potential impacts.

Development of the Biological Assessment will follow EPA guidance: *A Primer on Using Biological Assessments to Support Water Quality Management* (EPA 810-R-11-01, October 2011).

8.3 NEXT STEPS – REMEDIAL ACTION

Following completion of Final Design, Lockheed Martin will complete the Remedial Action Work Plan and perform the construction as outlined in the project schedule.

8.3.1 Remedial Action Work Plan

The Remedial Action Work Plan will provide a detailed description of the remediation and construction activities, including how construction activities (e.g., site-monitoring, material staging, and handling) are to be implemented by Lockheed Martin and coordinated with the EPA. The Remedial Action Work Plan will include, but not be limited to:

- The schedule for completion of the remedial action.
- Schedule for developing and submitting other required remedial action deliverables.
- Methods for satisfying permitting requirements.
- Tentative formulation of the remedial action team and lines of communication.
- Methodology for implementing the Contingency Plan(s).
- Project schedule.

After a contractor has been selected, the following deliverables will be included with submission of the Remedial Action Work Plan (unless previously submitted and approved by the EPA):

- Final CQAPs.
- Final Water Quality Monitoring Plan (with specific QAPP/FSP).
- Final QAPP/Final HASP/Final FSP for remedial action construction activities.
- Final LTMMP.
- Final Permitting and Site Access Plan.
- Final Site Management Plan (includes Contingency Plan, Pollution Control Plan, Transportation and Disposal Plan, Green and Sustainable Remediation Plan, and Climate Change Adaptation Plan).
- Final ICIAP (including draft or completed Proprietary Control Plan).
- Final Biological Assessment.
- Final Capital and Operation and Maintenance Cost Estimate.
- Final Project Implementation Schedule.
- Final Construction Quality Management Plan

- Erosion and Sedimentation Control Plan.
- Survey Plan.
- Archeological Monitoring and Discovery Plan.
- Dredge and Debris/Piling Removal Support System Plan.
- Dewatering Plan.
- Construction Water Management Plan.
- Settlement Monitoring Plan.
- Excavation, Dredging and Backfill Plan.
- Vessel Management Plan.
- Equipment Decontamination Plan.

8.3.2 Remedial Action Construction

Lockheed Martin will implement the remedial action as detailed in the approved Final Design and Final Remedial Action Work Plan. The following activities will be completed in constructing the remedial action.

- Performance monitoring and construction quality assurance
- Preconstruction inspection and meeting
- Remedial action progress meetings
- Pre-final and final construction inspections
- Remedial Action Construction and Completion Report and Final Close-Out Report

Section 9

Community Relations and Site Work Coordination

Participation by Lockheed Martin and their contractors in community involvement activities will be initiated at the request of the U.S. Environmental Protection Agency (EPA). EPA is the lead for all these activities. Specific support activities have not been identified, but we anticipate supporting EPA's community involvement activities related to the Lockheed West Seattle Superfund Site Statement of Work (SOW) by 1) providing information and data in formats easily understandable by the public, 2) attending and participating in public meetings which may be held or sponsored by EPA to explain activities at or concerning work performed pursuant to the Unilateral Administrative Order (UAO)/SOW, and 3) other activities requested by EPA.

Other remedial activities for which Lockheed Martin is not responsible have been performed, or will be performed following this project. EPA is currently performing long-term monitoring at the Pacific Sound Resources site to the west. The EPA is also overseeing the remedial design activities on the Lower Duwamish Superfund site along with the related remedial activities at Early Action sites in the Lower Duwamish Waterway. The Port of Seattle is currently redeveloping and upgrading the facilities at Terminal 5 adjacent to the Site. Lockheed Martin will continue to communicate and coordinate remedial activities at the Site with the EPA, the Port of Seattle, and other stakeholders to ensure that investigation and remediation can be completed in a timely manner.

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Section 10

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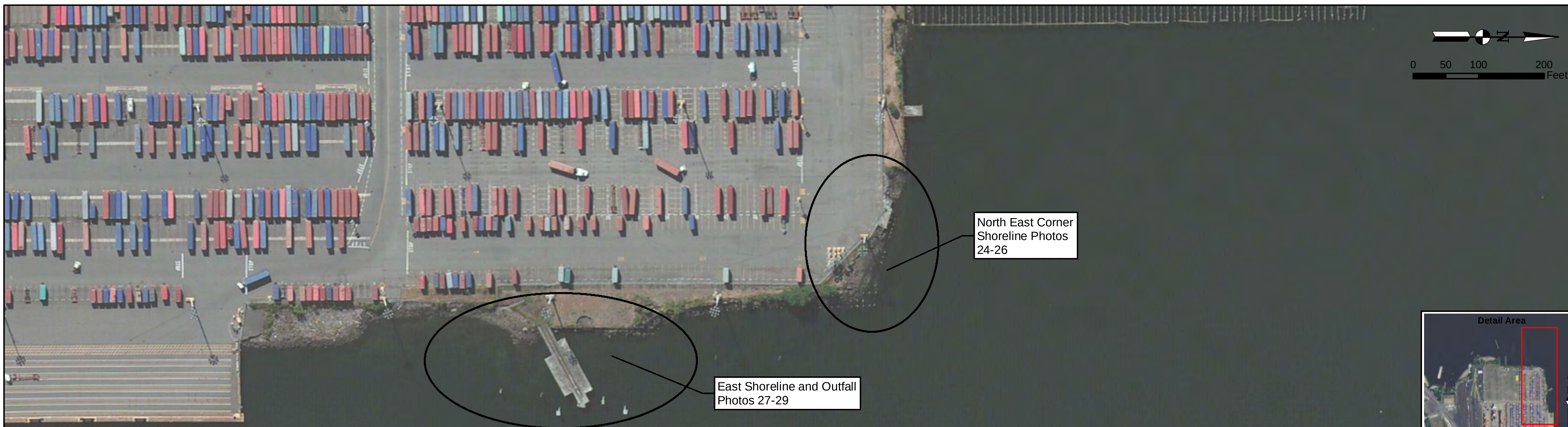
APPENDIX A— 2015 FIELD RECONNAISSANCE SITE VISIT PHOTOGRAPHS



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Lockheed West Seattle Superfund Site Seattle, WA

Appendix A Shoreline Photos Map

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Photo 1: Shipway sheet pile wall – general view

Photo 2: Shipway sheet pile wall – current condition

Photo 3: Shipway sheet pile wall – current condition

Photo 4: Shipway sheet pile wall – current condition

Photo 5: Shipway sheet pile wall – current condition

Photo 6: Shipway sheet pile wall – current condition

Photo 7: Shipway sheet pile wall – current condition

Photo 8: Shipway sheet pile wall – current condition

Photo 9: Shipway sheet pile wall – current condition

Photo 10: Sheet pile wall on the east side of Shipway

Photo 11: Buried sheet pile bulkhead wall

Photo 12: Miscellaneous steel frame (in water)

Photo 13: Sheet pile wall near north east corner – general view

Photo 14: Sheet pile wall near north east corner – current condition

Photo 15: Sheet pile wall near north east corner – current condition

Photo 16: Sheet pile wall near north east corner – current condition

Photo 17: Sheet pile wall near north east corner – current condition

Photo 18: Sheet pile wall near north east corner – current condition

Photo 19: Sheet pile wall near north east corner – current condition

Photo 20: Sheet pile wall near north east corner – current condition

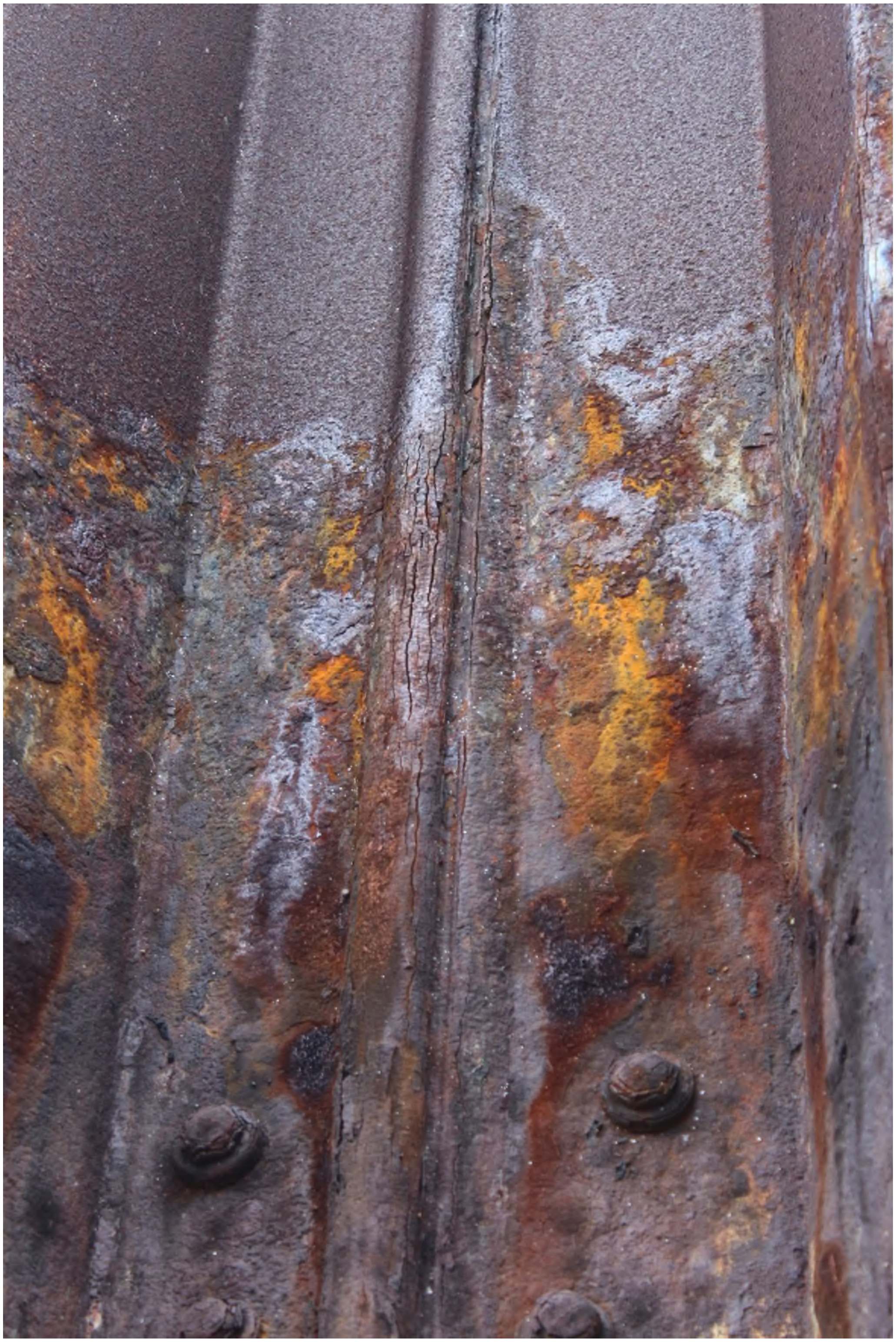

Photo 21: Sheet pile wall near north east corner – current condition

Photo 22: Pier 22A in front of sheet pile wall near north east corner

Photo 23: Pier 22A in front of sheet pile wall near north east corner

Photo 24: Concrete structure supported on timber piles near north east corner

Photo 25: Concrete structure supported on timber piles near north east corner

Photo 26: Concrete structure supported on timber piles and sheet pile wall near north east corner

Photo 27: Concrete pier on the east shore of the site

Photo 28: SW Florida Street Outfall discharge pipe looking from the West Waterway

Photo 29: SW Florida Street Outfall discharge pipe looking from the South

APPENDIX B— QUALITY ASSURANCE PROJECT PLAN

Appendix B

Pre-Design Investigation
Quality Assurance Project Plan
Lockheed West Seattle Superfund Site
Seattle, WA

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

September 21, 2015

Revision 1

Gary Braun
_____________________________ 09/21/2015
Project Manager Date
Gary Braun

Keir Craigie
_____________________________ 09/21/2015
Project Chemist Date
Keir Craigie

REVISION TABLE				
Revision Number	**Prepared By**	**Submittal Date**	**Change Description**	
			Section	**Narrative (of Items Affected)**
0	Tetra Tech, Inc.	7/20/2015	All	Draft
1	Tetra Tech, Inc.	9/21/2015	All	Final

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ATTACHMENTS

LIST OF TABLES

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ACRONYMS AND ABBREVIATIONS

%R	percent recovery
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ASTM	American Society for Testing and Materials
CIH	Certified Industrial Hygienist
DPM	Design Project Manager
DQO	Data Quality Objective
dw	dry weight
EPA	U.S. Environmental Protection Agency
FCR	Field Change Request
FSL	Field Sampling Lead
FSP	Field Sampling Plan
HASP	Health and Safety Plan
ICV	initial calibration verification
LCS	laboratory control sample
Lockheed Martin	Lockheed Martin Corporation
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
PARCC	precision, accuracy, representativeness, completeness, comparability
PCB	polychlorinated biphenyl
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control

RPD	relative percent difference
RSD	relative standard deviation
SD	standard deviation
SMS	Washington Sediment Management Standards
SOP	Standard Operating Procedure
SOW	Statement of Work
SQS	sediment quality standard
SPCC	system performance check compounds
SVOC	semivolatile organic compound
TT	Tetra Tech, Inc.
TOC	total organic carbon
UAO	Unilateral Administrative Order

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Section 1
Project Management

1.1 PROJECT ORGANIZATION

This Quality Assurance Project Plan (QAPP) provides the quality assurance/quality control (QA/QC) requirements for sediment sampling activities to be conducted at the Lockheed West Seattle Superfund Site (Site) by Tetra Tech, Inc. (TT) under the direction of Lockheed Martin Corporation (Lockheed Martin). The objective of this QAPP is to ensure that data quality requirements are established and fulfilled pertaining to collecting and evaluating site data. This QAPP has been prepared to define the QA and QC activities to be implemented, to ensure the integrity of the work to be performed at the site, and to ensure that the data collected will be of the appropriate type and quality needed for the intended use following U.S. Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (EPA, 2001).

TT-related documents referenced in this QAPP include the Field Sampling Plan (FSP), which describes field sampling activities, and the Environmental Health and Safety Plan (HASP). All field activities will be performed in compliance with the FSP. All parties generating data under this program are responsible for implementing the requirements presented in this QAPP.

Although QA/QC responsibilities lie principally with the TT Design Project Manager (DPM) and QA Manager, proper implementation of QA/QC requirements necessitate that the entire project staff be cognizant of all procedures and goals. A field program organization chart is presented as Figure 1-1.

Mr. Gary Braun will be the DPM for the Site investigation. He will be responsible for implementing and executing the technical, QA, and administrative aspects of the investigation, including the overall management of the project team. The DPM is also accountable for ensuring that the investigation is conducted in accordance with applicable plans and guidelines, including the FSP, the QAPP, and the HASP. In addition, the DPM will communicate all technical, QA, and administrative matters to the Lockheed Martin Project Manager. He will ensure that any deviations from the approved FSP, QAPP, and/or HASP Plan are documented in Field Change Request (FCR) forms, communicated to Lockheed Martin, and approved before implementation. The DPM is responsible for overseeing the preparation of project deliverables to be submitted by TT.

The overall management of the project-specific QA activities is the responsibility of the QA Manager, Mr. Keir Craigie. The QA Manager, or designee, is responsible for implementation of site-specific QA activities, including field and laboratory quality control. In addition, the QA Manager or his designee will coordinate with the DPM and other project staff, as applicable, during the reduction, review and reporting of analytical data.

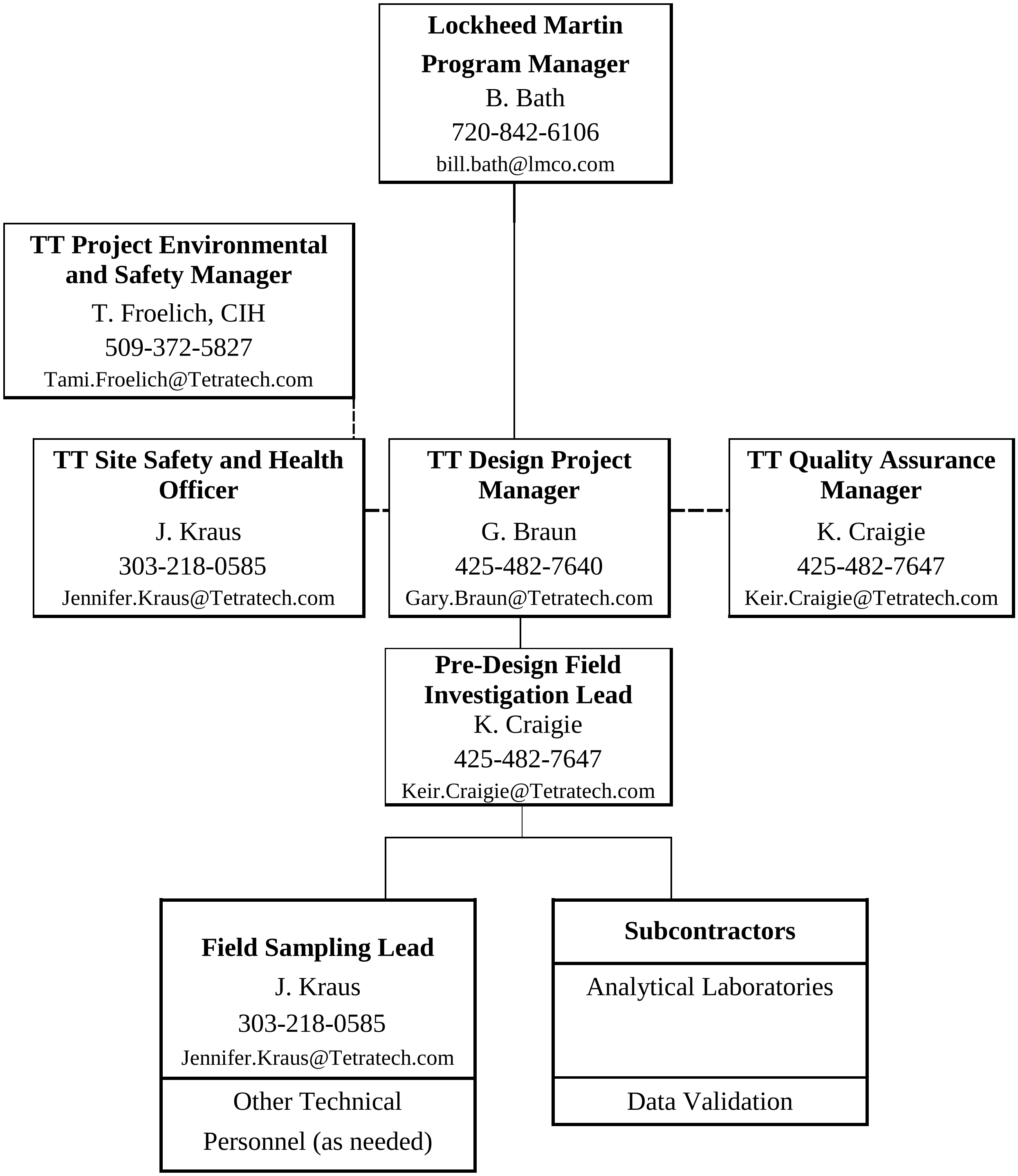
The Field Sampling Lead (FSL), Ms. Jennifer Kraus, is responsible for managing and supervising the field investigation program and providing consultation and decision-making on day-to-day issues relating to the sampling activities. The FSL shall monitor the sampling to ensure that operations are consistent with plans and procedures, and that the data acquired meets the analytical and data quality needs. When necessary, the FSL will document any deviations from the plans and procedures for approval.

The TT Project Environment and Safety Manager, Ms. Tami Froelich, is responsible for the implementation of the site-specific HASP. The Health and Safety Manager, through the cross-trained FSL, shall advise the project staff on health and safety issues, conduct health and safety training sessions, and monitor the effectiveness of the health and safety program conducted in the field.

The services of several subcontractors (e.g., laboratory services, data validation) will also be necessary for the performance of the field investigation and implementation of project objectives. The DPM, with assistance from the FSL as necessary and appropriate, will be the primary liaison between TT, the Lockheed Martin Project Manager, and each of the subcontractors. Subcontractors are responsible for performing work according to the requirements in this QAPP.

Chemical and physical analysis on the sediment samples collected for this project will be analyzed by accredited analytical laboratories. The project manager at each laboratory will be responsible for coordination with TT, QAPP implementation, and analytical data quality.

Figure 1-1. Program Organization Structure

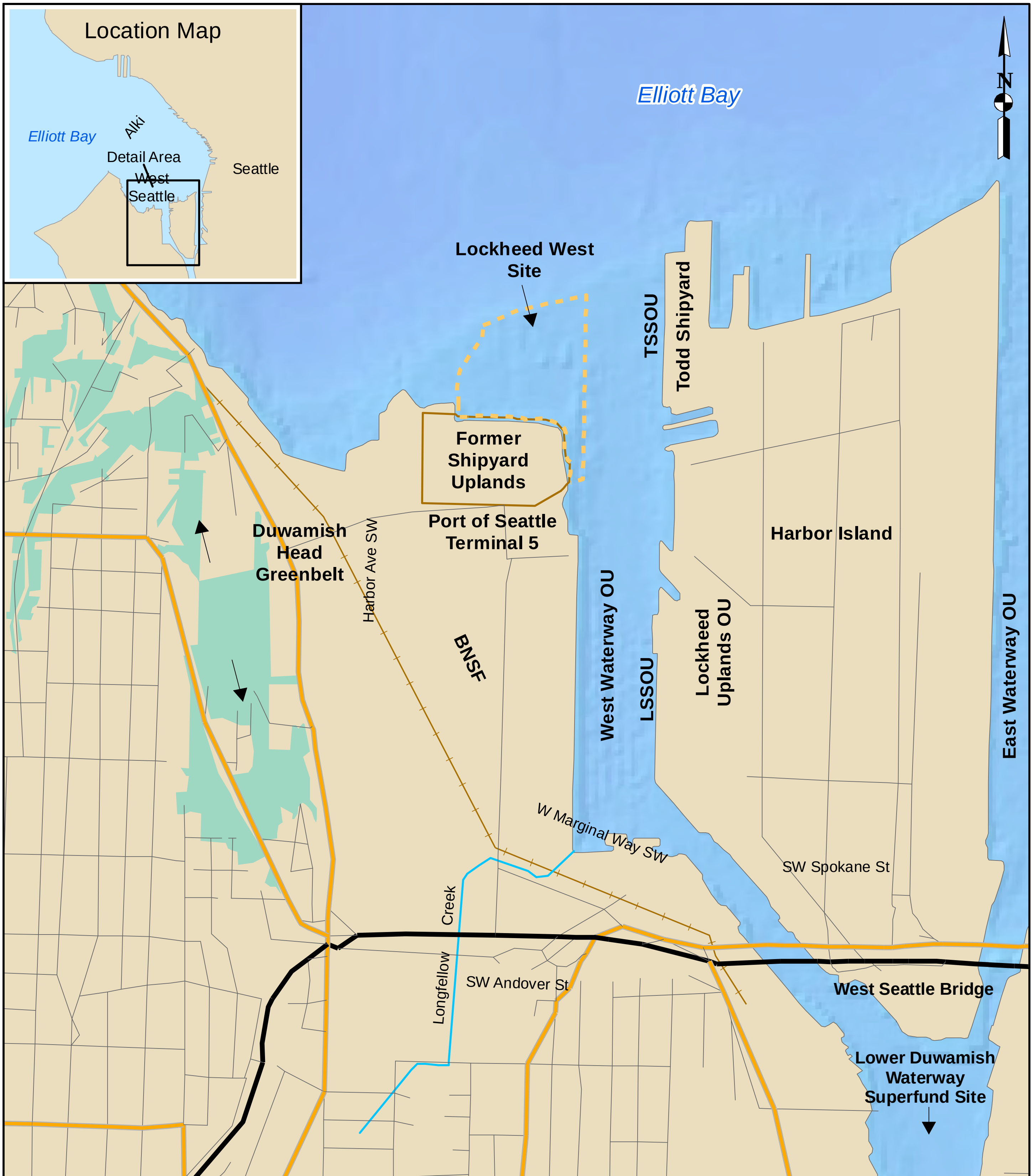


1.2 PROBLEM DEFINITION/BACKGROUND

This QAPP has been prepared by TT in accordance with the requirements of Section 3 of Attachment 1 to the Statement of Work (SOW), Appendix B to the Unilateral Administrative Order (UAO) (EPA Docket No. CERCLA-10-2015-0079/Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]) for the Site). The QAPP was prepared as a project planning document for the implementation of the chemical, geotechnical, physical, and structural characterization of the Site in support of the Remedial Design (RD).

The purposes of the UAO that pertain to this QAPP are to (a) dredge the former shipway area to remove sediment with contaminant of concern (COC) concentrations above the sediment quality standards (SQS); (b) dredge the Navigation Channel in the West Waterway to remove sediments with COC concentrations that exceed the SQS; (c) dredge the former Dry Docks 1 through 3 and other localized areas throughout the Site to remove sediments with COC concentrations above the cleanup screening levels (CSLs); (d) dredge the shoreline bank and intertidal zone to remove sediments with COCs at levels above the SQS, as structurally practicable; and (e) dispose of dredged sediments and other related remediation materials to an appropriate offsite upland facility.

The Site is located near the confluence of the West Waterway and Elliott Bay, in Seattle, Washington (Figure 1-2). The Site is bordered by Elliott Bay on the north, the Harbor Island West Waterway Operable Unit on the east, Pacific Sound Resources Marine Sediment Unit on the west, and the Port of Seattle Terminal 5 to the south (Figure 1-3). The Site includes the in-water marine sediments where the former Lockheed Shipyard No.2 was located (the shipway and dry docks were located in the water over the sediments). The Site also includes a narrow shoreline bank defined as areas extending from plus [+] 11.3 feet mean higher high water (MHHW) to intertidal sediments (exposed by low tides) at minus [-] 10 feet mean lower low water (MLLW) along the northern and eastern shorelines, as well as subtidal sediments (never exposed by low tides) that extend to -40 to -50 feet (MLLW) in historically dredged areas. The Site is impacted by tides with additional influence from the Lower Duwamish Waterway that flows into the West Waterway. In addition, numerous pilings remain within the footprint of the former shipway and pier structures in the northwestern portion of the Site.



Legend

	Site Boundary		Creek
	Highway		Railroad
	Major Road		Greenbelt
	Local Road	LSSOU	Lockheed Shipyard Sediment Operable Unit
	RA5 - Former Shipyard Uplands	TSSOU	Todd Shipyard Sediment Operable Unit
		OU	Operable Unit

Figure 1-2 Lockheed West Site Location and Vicinity Map

0 500 1,000
Feet

TETRA TECH

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Legend

Lockheed West Study Area

Harbor Lines

Pacific Sound Resources Marine Sediment Unit (approximate)

West Waterway OU (approximate)

RA5 - Former Shipyard Uplands

Removal to CSL in Dry Dock Areas

Dredge to SQS in West Waterway Navigation Channel

Removal to SQS in Shoreline/Intertidal and Former Shipway Areas

ENR to Study Area Boundary

Former Dry Dock Areas

Habitat Mix

Riprap Armor Stabilization

Backfill to Existing Elevations

Habitat Softening/Enhancement in Existing Riprap Areas

Remnant Piling Areas (Other Small Areas of Remnant Piling are Excluded)

2007 and Earlier Sampling Locations

Intertidal Surface Grab

■ Subsurface Core

● Surface Grab

⬟ Geotechnical Boring

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Notes:
AC = Acre
CSL = Cleanup Screening Level
CY = Cubic Yard
ENR = Enhanced Natural Recovery
SQS = Sediment Quality Standard

N

0 125 250 500 Feet

Lockheed West Site
Seattle, WA

Figure 1-3
Site Area with Historical Sample Locations

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In total, the Site encompasses 40 acres of aquatic lands, including approximately 33 acres of state-owned aquatic lands managed by the Washington State Department of Natural Resources and 7 acres of Port-owned aquatic tidelands. The Site is not currently used for Port-related or other commercial activities, but the Port envisions expanding Terminal 5 pier structures to include a multi-modal container terminal along the West Waterway. The Site and adjacent aquatic areas are designated as Tribal Usual and Accustomed Fishing Areas. The public is allowed to access the bank and intertidal portions of the Site from the water. Access via land is currently restricted due to fencing around Terminal 5; however, public access would be possible from the west via Jack Block Park if fencing were removed.

The Site is located in a historically industrialized and commercial area of Seattle. There are several nearby environmental cleanup projects and major drainage discharges in the vicinity. The primary land uses near the Site have been industrial and maritime for over a century. The adjoining area of the West Waterway includes a federally maintained navigation channel and numerous privately maintained berthing areas.

Lockheed Martin discontinued operations at Lockheed Shipyard Number 2 in 1987 after approximately 41 years of continuous operations, primarily shipbuilding, ship repair and maintenance. Past industrial practices at or adjacent to the facility have resulted in contamination of upland soils and adjacent aquatic sediments. The contaminants found in the aquatic area include hazardous substances commonly associated with shipbuilding, repair and maintenance activities, consistent with the historical uses of the facility.

Contaminants of concern in the Site include, but are not limited to, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), mercury, other metals and organic compounds.

Associated sediments are habitat to numerous fish and other aquatic species, and are within a migratory corridor for endangered, threatened, and other anadromous fish.

On August 28, 2013, EPA issued the Record of Decision for the Site based on the area identified in the Remedial Investigation/Feasibility Study that warranted remedial action.

1.3 PROJECT DESCRIPTION

The objective of this project is to collect specific data to address current data gaps in the characterization of the sediments and support the RD for the sediments at the Site. Surface and subsurface samples will be collected to evaluate the chemical and physical characteristics of the sediment. These samples will be analyzed for chemicals of concern, geotechnical properties and physical characteristics and will also be used for dewatering tests. Chemical concentration results, the geotechnical data, physical data and structural evaluation data along with the results of the dewatering tests will support the development of the RD.

The primary tasks that will be completed for this project include sediment sample collection within the Site. Sediment core samples will be collected using a sonic drilling, hollow-stem auger, or vibracore technique. Surface sediment samples will be collected using a Van Veen grab sampler. Samples will be analyzed for project-specific parameters to evaluate the chemical, geotechnical and physical characteristics of the site. The chemical parameters of interest for sediment samples include PCB Aroclors, the semivolatile organic compounds (SVOCs) pentachlorophenol and bis(2-ethylhexyl) phthalate, metals, total organic carbon (TOC), and Tributyltin. Physical parameters of interest include moisture content, Atterberg Limits, and grain size.

1.4 DATA QUALITY OBJECTIVES

This section of the QAPP documents the project data quality objectives (DQOs) and establishes the performance criteria for the planning and measurement system that will be used to generate data. DQOs apply to field and analytical data, as well as data verification, reduction, and evaluation activities. The QC requirements for this project include procedures to promote data quality and collect QC samples that provide data of a measurable quality.

1.4.1 Project Quality Objectives

DQOs provide criteria against which project performance can be evaluated to determine whether the overall project QA objectives are met. The objectives will be met by collecting data of sufficient quality and quantity that can be used for the intended purposes. DQOs can be defined as what the end user expects to obtain from the analysis results. DQOs are developed through a seven-step process. The DQOs for this project are defined below using the seven-step process described in EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

State the Problem. Sediment samples must be collected within the Site to address data gaps in the extent of contamination, geotechnical characteristics of the shoreline and sediment, and conditions of structures along the shoreline in support of the development of the RD.

Identify the Decision. A decision must be made from the data collected to determine whether target analytes are present in sediments at levels exceeding the project-specific action levels as defined in the UAO and SOW, what the stability of the shoreline and sediments are for the planned remedy and what the current conditions of shoreline sheet pile walls are.

Identify Inputs to the Decision. Inputs to the decision include the following:

- Analytical and geotechnical data resulting from sediment samples collected within the Site
- Corrosion and strength data for components from the sheet pile walls along the shoreline
- Project-specific action levels
- Analytical method reporting limits
- Existing data from the Remedial Investigation and previous site investigations

Define the Study Boundaries. Data collected in this study will focus on the target analytes known to exist at the site and geotechnical data required to evaluate slope stabilities. The geographic boundaries of this study include the sediment and soil at the sample locations.

Develop a Decision Rule. The decision rules are defined as follows:

- If target analytes are not detected at concentrations above the identified action levels for the Site area, no further action is required.
- If target analytes are detected above identified action levels for the Site area, the data will be used to refine the extents of remedial action in the RD.

Specify Limits on Decision Errors. The decision rules will be applied using valid analytical data derived from the samples. Sample locations have been selected to address identified data gaps in the characterization of the extents of sediment contamination at the site. Method data quality requirements for precision and accuracy will be used to determine the validity or usability of the data. The analytical method precision and accuracy requirements are defined in the individual laboratory procedures and laboratory quality assurance plans.

Optimize the Design for Obtaining Data. Sampling to address data gaps and support the RD has been developed to provide the most cost-effective design for sample collection and to allow for additional analyses where needed. Targeted initial sample analyses have been selected based on historic data and additional samples will be collected and archived for potential analyses where required. Geotechnical data are planned for collection from upland locations and sediment locations to provide correlations between paired locations and to correlate with previously collected geotechnical data. This study will be performed to allow for minimization of the number and types of samples collected while supplying sufficient data upon which to apply the decision rules.

The DQOs for the Lockheed West project are included in Table 1-1.

Table 1-1
Data Quality Objectives

Step 1 Statement of Problem	Step 2 Decisions	Step 3 Inputs to the Decisions	Step 4 Boundaries of the Study	Step 5 Decision Rules	Step 6 Units on Decision Errors	Step 7 Optimize the Sampling Design
Determine the depth of dredging and volume of sediment to be removed where deepest intervals collected in the Remedial Investigation (RI) cores had concentrations greater than the site action levels.	Additional data required to determine the depth of removal.	Additional data collected from below the limit of the historic data.	Samples to be collected from within identified areas for removal based on the RI data collected. Depths to be collected below the limits of the historic cores collected.	Collected data will be compared to the remedial action levels for the site (WA state CSL and SQS).	The collection and analysis of subsurface cores will utilize EPA-approved methods and definitive quality levels.	The additional sampling has been optimized based on previously collected cores. Additional sample intervals will be collected and archived for possible analysis if needed to define the depth of contamination above the CSL and/or SQS levels.
Determine if accumulated sediment on the concrete area of the shipway requires removal.	Data required to determine if the accumulated sediment requires removal due to contamination above cleanup action levels.	Data to be collected from the sediment accumulated on the concrete area of the shipway.	Samples to be collected from the area of accumulated sediment at the south end of the shipway concrete area.	Collected data will be compared to the remedial action levels for the site (WA state CSL and SQS).	The collection and analysis of subsurface cores will utilize EPA-approved methods and definitive quality levels.	The sampling will be conducted by collecting full depth cores to refusal and analyzing for site COCs.
Determine the volume of sediment to be removed from the shipway area where pilings are currently located.	Additional data required to determine the depth of removal.	Data to be collected from the sediment in the area of the dense pilings off of the shipway.	Samples to be collected from the area of the pilings off of the shipway. Samples will be collected to 10 feet or refusal, whichever is encountered first.	Collected data will be compared to the remedial action levels for the site (WA state CSL and SQS).	The collection and analysis of subsurface cores will utilize EPA-approved methods and definitive quality levels.	The sampling has been designed to provide coverage across the area of the pilings. Additional sample intervals will be collected and archived for possible analysis if needed to define the depth of contamination above the SQS levels.

Table 1-1
Data Quality Objectives

Step 1 Statement of Problem	Step 2 Decisions	Step 3 Inputs to the Decisions	Step 4 Boundaries of the Study	Step 5 Decision Rules	Step 6 Units on Decision Errors	Step 7 Optimize the Sampling Design
Confirm the need and determine the extent of sediment to be dredged at localized areas where one sample was collected previously indicating an exceedance of the site action levels.	Data required to confirm and delineate the extent of sediment with concentrations of COCs above the action levels for removal.	Data to be collected at locations where historic samples have concentrations above the action levels for removal and from locations around to define the areal extent of sediment for removal.	Samples to be collected at and around the location of historic samples.	Collected data will be compared to the remedial action levels for the site (WA state CSL and SQS).	The collection and analysis of surface grab samples and subsurface cores will utilize EPA-approved methods and definitive quality levels.	The sampling has been designed to provide coverage across the area of the historic locations. Additional sample intervals and surface step out samples will be collected and archived for possible analysis if needed to define the areal extent and depth of contamination above the CSL and/or SQS levels.
Determine the volume of material to be removed and replaced along the shoreline and intertidal areas of the site.	Data required to confirm and delineate the extent of sediment with concentrations of COCs above the action levels for removal.	Data to be collected from areas with soft sediment present along the shoreline and intertidal areas planned for removal.	Shoreline and intertidal areas where soft sediment is present between -10 and 4 feet MLLW.	Collected data will be compared to the remedial action levels for the site (WA state CSL and SQS).	The collection and analysis of subsurface cores will utilize EPA-approved methods and definitive quality levels.	The sampling has been designed to provide coverage across the area of accessible shoreline and intertidal beaches. Additional sample intervals will be collected and archived for possible analysis if needed to define the depth of contamination above the CSL and/or SQS levels.

Table 1-1
Data Quality Objectives

Step 1 Statement of Problem	Step 2 Decisions	Step 3 Inputs to the Decisions	Step 4 Boundaries of the Study	Step 5 Decision Rules	Step 6 Units on Decision Errors	Step 7 Optimize the Sampling Design
Sediment stability along the shoreline.	Data required to determine the stability of the shoreline slope and sediment slope stabilities for dredging.	Geotechnical data will be collected from the uplands and subtidal areas along the shoreline. Historic geotechnical core data will be used along with newly collected data.	Upland and subtidal areas along the shoreline slope.	Collected data will be evaluated to determine slope stabilities.	Collection of cone penetration test data, seismic cone penetration test data, field van shear data and samples for laboratory geotechnical strength tests. Multiple data types to provide correlations between the analyses.	Sampling to be conducted to collect multiple types of geotechnical data from locations so the tests and locations can be correlated. Locations selected to also use historic geotechnical data collected at the site.
Current condition and stability of support structures along the Shoreline.	Data required to determine the current conditions and stability of the sheet pile wall structures along the shoreline.	Data on the level of corrosion and tensile strength will be collected to determine the current conditions of the sheet pile walls.	Sheet pile walls located on the north shoreline of the site and in the shipway.	Collected data will characterize the current conditions of the sheet pile wall structures.	Field survey and laboratory tests will be used to evaluate the condition of the sheet pile walls.	Collected samples will be representative of the sheet pile wall materials.
Determine the dewatering characteristics of the sediment to the dredged.	Data required to evaluate the amount of water that will be released from the sediments planned for removal.	Data to be collected that are representative of the sediments in the areas planned for removal.	Samples to be collected from within the identified dredge areas.	The amount of water released from the sediments will be evaluated with and without the addition of amendments.	Results from various amendment additions will be used to evaluate the dewatering characteristics of the sediments for design purposes.	The sediments will be prepared with site water to evaluate the amount of water released. Amendments may be added to compare to where no amendment is added.

Table 1-1
Data Quality Objectives

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Statement of Problem	**Decisions**	**Inputs to the Decisions**	**Boundaries of the Study**	**Decision Rules**	**Units on Decision Errors**	**Optimize the Sampling Design**
Current site conditions and extent of debris.	Data required to evaluate the current sediment mudline surface and extent of debris at the Site.	Bathymetry survey will be completed for the Site area along with sidescan sonar and magnetometer survey to identify and quantify debris present.	Subtidal area of the Site.	Collected data will be evaluated during the design phase to refine implementation of the remedy.	Bathymetry and data for debris identification will be georeferenced with high quality GPS data from benchmark stations established for the survey.	The survey will be completed for the entire subtidal area of the site.

1.4.2 Measurement Performance Criteria

The DQO process provides a logical basis for linking the QA/QC procedures to the intended use of the data, primarily through the decision maker's acceptable limits on decision error. The overall QA/QC objective for the field investigation is to develop and implement procedures that will provide data of known and documented quality. QA/QC characteristics for data include precision, accuracy, representativeness, completeness, and comparability (PARCC). This section provides a description of specific routine procedures to assess PARCC parameters. The QA objectives for analytical data for the field samples include the following, where appropriate.

Precision

Precision is the measurement of agreement in repeated tests of the same or identical samples, under prescribed conditions. Analytical precision can be expressed in terms of standard deviation (SD), relative standard deviation (RSD) and/or relative percent difference (RPD). The precision of analytical environmental samples has two components: laboratory precision and sampling precision. Laboratory precision is determined by replicate measurements of laboratory duplicates. Generally, results from the matrix spike (MS)/matrix spike duplicate (MSD) samples and laboratory duplicate samples are used to measure laboratory precision. The precision requirements for the laboratory analyses are specified in the appropriate laboratory Standard Operating Procedures (SOPs) and analytical methodologies. Overall precision of the field sampling and analysis effort is determined by an evaluation of field duplicate samples. Field duplicate analysis will be performed at a rate of 10 percent (i.e., one duplicate collected for every 10 samples).

1.4.3 Accuracy

Accuracy is the degree of agreement of a measured sample result or average of results with an accepted reference or true value. It is the quantitative measurement of the bias of a system, and it is usually expressed in terms of percent recovery (%R). The accuracy of the sample analyses will be determined in accordance with the specifications contained in the laboratory SOPs established through the evaluation of surrogate spike, laboratory control samples, and MS and/or MSD samples.

1.4.4 Representativeness

Representativeness expresses the degree to which the results of the analyses accurately and precisely represent a characteristic of a population, a process condition, or an environmental condition. In this case, representativeness is the degree to which the data reflect the contaminants present and their concentration magnitudes in the sampled site areas. Representativeness of data will be ensured through the selection of proper sampling locations and implementation of approved sampling procedures. Results from environmental field duplicate sample analyses can be used to assess representativeness, in addition to precision.

1.4.5 Comparability

Comparability represents the degree of confidence with which results from two or more data sets, or two or more laboratories, may be compared. To achieve comparability, standard environmental methodologies (as prescribed in the procedures outlined in the FSP, the QAPP, and the laboratory SOPs) will be employed in the field and in the laboratory.

1.4.6 Completeness

Completeness is defined as the percentage of samples that meet or exceed the criteria objective levels for accuracy, precision and reporting limits within a defined time period or event. It is the measure of the number of data "points" that are judged as valid, usable results. Completeness can be ensured by collecting an adequate number of samples to accomplish project objectives.

1.5 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

TT will establish requirements for training and qualification of project personnel to ensure that they are capable of performing investigation activities. The TT QA Manager, in consultation with the TT DPM, will establish and implement a program for the TT staff involved in the project, to ensure compliance with the FSP, the QAPP, and the HASP.

Performance-based testing will be provided to all appropriate personnel performing project activities. TT's performance-based testing involves the review of the personnel's work products by the TT DPM, FOL, and/or QA Manager, until the monitored individual reaches the desired level of competence in performing his work tasks. Once a person exhibits the required degree of competence, unannounced periodic monitoring is performed to ensure this level is maintained.

1.5.1 Project-Specific Personnel Training

Project staff shall receive general training on the project objectives, the DQOs for the site, the FSP, the QAPP, and the HASP.

Quality assurance training will cover, but is not solely limited to, the following:

- QAPP elements, including project-specific QA requirements
- Need for proper documentation and records maintenance
- Responsibilities of project personnel
- Handling and review of field, laboratory, and non-direct measurement data

TT will assure that all personnel performing site activities shall receive training on their respective tasks. In general, training shall be provided to accomplish the following:

- Initial proficiency
- Maintain proficiency
- Adapt to changes in technology, methods, or job responsibilities

The extent of training will be commensurate with the following objectives:

- Scope, complexity, and nature of the activity to be performed
- Prior education, experience, and proficiency of personnel

1.5.2 Training Records

TT will complete and maintain all training records in the project files. They will include the following, as appropriate:

- Attendance sheets
- Training logs
- Personnel training record
- Formal qualification/certification records (as applicable)

All site personnel will have 40-hour Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response training and current annual 8-hour refresher training.

1.6 DOCUMENTATION AND RECORDS

Reporting for this project includes laboratory reports, quality assurance reports, and the final report. Below are outlines of the various reports that will be prepared for the tasks to be completed as part of the Pre-Design investigation. These individual reports will be compiled and included in the Pre-Design Investigation Data Report.

1.6.1 Laboratory Reports

Final written laboratory reports will be required for both chemical and physical analyses. Key elements of these reports are described below. It is expected that these reports, or summaries of these reports (as appropriate), will be appended to the final report.

1.6.2 Chemistry Reports

Final written laboratory reports and data deliverables will contain the following:

- Case narrative
- Identification of all protocols
- Summary results of initial and continuing calibrations
- Method and instrument blanks
- All field sample and field QA/QC sample results
- Surrogate recoveries (organic analyses)
- Matrix spikes (organics, batch specific)
- Matrix spike duplicates (organics only, batch specific)
- Supporting raw data and spectra
- Supporting sample tracking information (e.g. shipping forms, chain-of-custody forms)
- Supporting documentation on any corrective actions

Initial calibration information must include concentrations of each standard analyzed, response factors for each analyte at each standard concentration, relative standard deviation (RSD) (or correlation coefficient for metals analytes) over all standards for individual analytes. The RSD control limit range must also be indicated in the initial calibration summary data.

Continuing calibration information must include the response factor (organic analytes) for each analyte, and the calculated percent difference as compared to initial calibration (organic analytes). Control limits for each analyte must also be indicated on each continuing calibration summary data sheet.

Method blank and field sample data pages must indicate the method reporting limit and the dilution factor. Surrogate reporting forms must list control limits for surrogate recovery. Spike reporting forms (blank and matrix spikes) must indicate spike percent recovery and relative percent difference control limits (if spikes are analyzed in duplicate).

Electronic data deliverables will also be required.

1.6.3 Geotechnical Report

Final written laboratory reports and data deliverables will include the following:

- A short write-up on laboratory methods, sample identifications, and problems encountered during testing
- Grain size data and Atterberg limits presented on graphs
- Results for the laboratory strength tests
- A copy of the chain-of-custody forms

1.6.4 Sheet Pile Strength Laboratory Report

Final written laboratory reports and data deliverables will include the following:

- A short write-up on laboratory methods, sample identifications, and problems encountered during testing
- Full results for the corrosion and strength tests on the materials from the sheet pile walls submitted

1.6.5 Cone Penetration Testing Report

Final written reports and data deliverables will include the following:

- A short write-up on methods, sample identifications, and problems encountered during testing
- Full set of results from the Cone Penetration Testing with graphs and tables presenting the tip resistance and sleeve friction along with correlations to soil classification and strength.

1.6.6 Sediment Dewatering Testing Report

- A short write-up on laboratory methods, sample identifications, and problems encountered during testing
- Full set of results from the dewatering tests, with tables presenting the solids concentrations, unit weight, specific gravity, organic matter, amendment testing results, total suspended solids, and paint filter tests.

1.6.7 Data Validation Report

The project QA representative will prepare a report based upon a review of the laboratory analytical data. An independent data validation will be completed. The laboratory quality assurance/quality control (QA/QC) reports and any data package validation reports will be incorporated by reference. This report will identify any laboratory activities that deviated from the approved referenced protocols and will make a statement regarding the overall validity of the data collected. The data validation report will be incorporated into the final report.

1.6.8 Field Sampling Data Report

A written report will be prepared documenting all activities associated with collection, compositing, and transportation of samples. At a minimum, the following will be included in the field sampling report:

- Brief description of the project and its objectives
- Type of sampling equipment used
- Identification and description of protocols used during sampling and testing and an explanation of any deviations from the sampling plan protocols
- Description or summary of sampling and compositing procedures
- Descriptions of each sample and the sediments (i.e., core logs and sample logs)
- Summary of methods used to locate the sampling positions, and a discussion of the position accuracy
- Locations where the sediment samples were collected. Locations will be reported in NAD 83 State Plane Coordinates
- A plan view of the project showing the actual sampling locations

In addition to the items listed above, the report will include an electronic file of sample location information (i.e., sample ID, sample type, coordinates, sample data, water depth, and sample depth).

Section 2

Measurement Data Acquisition

2.1 SAMPLING PROCESS DESIGN

The rationale for the proposed sampling approach is based on the assessment of existing data and identification of data gaps (see Section 6.1 of the Remedial Design Work Plan). The primary objectives of sediment sampling and analysis are refinement of the spatial resolution of chemical contaminant concentrations above the action level and the collection of geotechnical and physical data to support the development of the Remedial Design. These data will be used to refine remediation areas and volumes of sediment that require dredging.

The project team will be responsible for the tasks associated with the collection of sediment and site characterization data for Lockheed West. The proposed scope of work includes:

- Collection and analysis of samples for:
  - Chemical, geotechnical, and physical testing, and
  - Site characterization for developing the remedial design
- Data analysis, interpretation, and reporting.

2.2 SAMPLING METHODS REQUIREMENTS

A synopsis of the pre-Remedial Design field program is provided below. Sediment chemical data will be used to define the maximum dredging depth and areal extent of dredge areas. Geotechnical data will be used to evaluate the stability of the shoreline slope and stability of slopes in dredge areas. Structural strength data will be used to evaluate the current conditions of the sheet pile walls along the north uplands shoreline of the site and within the shipway.

Surface Sampling. Surface sampling locations have been selected to be representative of the surface sediment conditions and to provide adequate spatial coverage of the site. Surface samples will be collected for bulk chemical analysis. Subtidal surface samples will be collected using standard Van Veen grab methods deployed from a work vessel.

Subsurface Sampling (including CPT, seismic CPT and geotechnical borings). Subsurface sampling will be performed using a sonic coring, hollow-stem auger, or vibracore system. Data gathered from the subsurface cores will be used to physically and chemically characterize the sediment and soils and refine the extent and depths of dredging to be conducted. Sample locations have been selected to address specific data gaps identified across the site. The coring system will be operated from a barge that will be securely anchored at each sampling location. Hand auger and vibracoring may be performed in the nearshore areas of the shipway where pilings are present inhibiting the larger drilling equipment.

Most subsurface cores will be advanced beyond the deepest extent of remedial action level exceedances indicated by the existing data or to native material. Several cores will be penetrated to 20 feet below the mudline to define the bottom of dredging in the dry dock areas. The primary objectives will be to determine the vertical extent of sediment requiring dredging and refine the areal extent of sediment to be removed.

Proposed sample locations are included in Table 2-1 and shown on Figure 2-1.

Table 2-1
Proposed Sediment Samples

Location	Type (Target revisit core)	Proposed Easting[1]	Proposed Northing[1]	Ground/ Mudline Elevation (MLLW)	Sample Depth (Feet)	Target Elevation (MLLW)	Conventionals[2]	metals	SVOC[3]	PCB	TBT bulk	Geotechnical[5]	CPT/Seismic CPT	Field Vane Test	Dewatering
TT-101	Core	1262202.16	216964.91	7.0	3 (refusal)	4.0	x	x	x	x	x				
TT-102	Core	1262260.06	216969.05	5.5	3 (refusal)	2.5	x	x	x	x	x				
TT-103	Core	1262207.81	217065.59	-0.5	10 (refusal)	-10.5	x	x	x	x	x				x
TT-104	Core	1262247.10	217071.79	-1.0	10 (refusal)	-11.0	x	x	x	x	x				x
TT-105	Core	1262200.31	217146.47	-5.9	10 (refusal)	-15.9	x	x	x	x	x				x
TT-106	Core	1262243.74	217150.60	-4.7	10 (refusal)	-14.7	x	x	x	x	x				x
TT-107	Core	1262191.83	217250.26	-25.8	10 (refusal)	-35.8	x	x	x	x	x				x
TT-108	Core	1262237.32	217260.59	-26.1	10 (refusal)	-36.1	x	x	x	x	x				x
TT-109	Core	1262530.93	217018.67	-24.4	15	-39.4	x	x	x	x	x				
TT-110	Core	1262605.37	217016.60	-26.0	15	-41.0	x	x	x	x	x				
TT-111	Surface Grab	1262776.25	217226.41	-25.5	0.5	-26.0	x	x	x	x	x				
TT-112	Core (TT20)	1262787.31	217301.02	-28.4	10	-38.4	x	x	x	x	x				
TT-113	Surface Grab	1262777.66	217340.52	-26.1	0.5	-26.6	x	x	x	x	x				
TT-114	Core	1262725.40	217660.92	-29.2	0.5	-29.7	x	x	x	x	x				
TT-115	Surface Grab	1262776.34	217593.00	-29.8	0.5	-30.3	x	x	x	x	x				
TT-116	Core	1262764.58	217655.53	-28.1	10	-38.1	x	x	x	x	x				
TT-117	Surface Grab	1262787.66	217691.10	-36.4	0.5	-36.9	x	x	x	x	x				
TT-118	Core	1262917.59	217128.26	-24.7	15	-39.7	x	x	x	x	x				
TT-119	Core	1262927.93	217330.90	-23.1	15	-38.1	x	x	x	x	x				
TT-120	Core	1262998.23	216983.52	-22.7	15	-37.7	x	x	x	x	x				
TT-121	Core (TT18-CS)	1263081.03)	217034.24	-32.2	20	-52.2	x	x	x	x	x				x
TT-122	Core	1263099.55	216979.39	-29.4	15	-44.4	x	x	x	x	x				
TT-123	Core	1263200.87	216954.57	-20.7	15	-35.7	x	x	x	x	x				
TT-124	Core (TT07-CS)	1263201.05	216856.46	-8.8	20	-28.8	x	x	x	x	x				
TT-125	Core	1263190.53	216789.16	-1.1	5	-6.1	x	x	x	x	x				
TT-126	Core	1263215.34	216650.62	-13.8	5	-18.8	x	x	x	x	x				
TT-127	Core	1263196.73	216297.04	5.0	5	0.0	x	x	x	x	x				
TT-128	Core	1263194.66	216210.20	2.0	5	-3.0	x	x	x	x	x				

Table 2-1
Proposed Sediment Samples

Location	Type (Target revisit core)	Proposed Easting[1]	Proposed Northing[1]	Ground/ Mudline Elevation (MLLW)	Sample Depth (Feet)	Target Elevation (MLLW)	Conventionals[2]	metals	SVOC[3]	PCB	TBT bulk	Geotechnical[5]	CPT/Seismic CPT	Field Vane Test	Dewatering
TT-129	Core	1263190.53	216113.02	2.0	5	-3.0	x	x	x	x	x				
TT-130	Core	1263231.88	216113.02	-2.0	5	-7.0	x	x	x	x	x				
TT-131	Core	1263223.61	216212.27	-1.0	5	-6.0	x	x	x	x	x				
TT-132	Core	1263231.88	216292.91	1.0	5	-4.0	x	x	x	x	x				
TT-133	Core	1263318.73	217587.29	-36.4	15	-51.4	x	x	x	x	x				
TT-134	Core	1263262.90	217268.87	-24.9	15	-39.9	x	x	x	x	x				
TT-135	Core	1263252.56	216842.92	-31.7	15	-46.7	x	x	x	x	x				
TT-136	Core (TT04-CS)	1263317.53	216183.74	-26.2	20	-46.2	x	x	x	x	x				
TT-137	Core	1263513.09	218176.59	-47.0	10	-57.0	x	x	x	x	x				
TT-138	Core (TT34-CS)	1263425.08	218122.15	-51.6	10	-61.6	x	x	x	x	x				
TT-139	Core	1263438.65	217049.69	-41.4	15	-56.4	x	x	x	x	x				
TT-140	Core (TT08-CS)	1263374.92	216865.05	-38.9	20	-58.9	x	x	x	x	x				x
TT-141	Core (TT30-CS)	1263496.45	216827.46	-50.9	5	-55.9	x	x	x	x	x				
TT-142	Core	1263430.38	216799.50	-44.3	15	-59.3	x	x	x	x	x				
TT-143	CPT/FV/Core	1262232.37	217334.71	-27.1	50 (CPT)/25 FV/20 Core	-77.1/-52.1/-47.1						x	x	x	
TT-144	CPT/Core	1262235.17	216902.90	13.0	100100 (CPT)/20 Core	-979.0/-7.0						x	x[5]		
TT-145	FV/Core	1262386.36	217176.76	-32.8	25 (FV)/20 Core	-57.8/-52.8						x		x	
TT-146	CPT/FV/Core	1262563.10	217071.93	-35.9	50 (CPT)/25 FV/20 Core	-85.9/-60.9/-55.9						x	x	x	
TT-147	CPT/Core	1262644.36	216886.53	3.9	80 (CPT)/20 Core	-76.1/-16.1						x	x		
TT-148	FV/Core	1263052.21	217072.86	-38.2	25 (FV)/20 Core	-63.2/-58.2						x		x	

Table 2-1
Proposed Sediment Samples

Location	Type (Target revisit core)	Proposed Easting[1]	Proposed Northing[1]	Ground/ Mudline Elevation (MLLW)	Sample Depth (Feet)	Target Elevation (MLLW)	Conventionals[2]	metals	SVOC[3]	PCB	TBT bulk	Geotechnical[5]	CPT/Seismic CPT	Field Vane Test	Dewatering
TT-149	CPT/Core	1263043.30	216864.66	3.6	10010 (CPT)/20 Core	-969.4/-16.4						x	x[5]		
TT-150	CPT/FV/Core	1263227.21	216979.36	-25.5	50 (CPT)/25 FV/20 Core	-75.5/-50.5/-45.5						x	x	x	
TT-151	FV/Core	1263246.10	216804.39	-28.3	25 (FV)/20 Core	-53.3/-48.3						x		x	
TT-152	CPT/Core	1263149.20	216239.39	11.0	100100 (CPT)/20 Core	-8989.0/-9.0						x	x[5]		
TT-153	CPT/FV/Core	1263315.40	216474.37	-16.2	60 (CPT)/25 FV/20 Core	-76.2/-41.2/-36.2						x	x	x	
TT-154	FV/Core	1263326.46	216149.06	-25.8	25 (FV)/20 Core	-50.8/-45.8						x		x	
TT-155	CPT/Core	1262034.72	217003.45	3.9	80 (CPT)/20 Core	-76.1/-16.1						x	x		
TT-156	Core	1263009.35	217226.15	-38.1	10	-48.1									x
TT-157	Core	1263181.94	217462.76	-44.2	10	-54.2									x
TT-158	Core	1263326.69	216658.27	-41.5	10	-51.5									x
TT-159	Core	1263318.02	217075.83	-42.4	10	-52.4									x
TT-160	Surface Grab (Hold)	1262776.86	217131.43	-26.2	0.5	-26.7	x[4]	x[4]	x[4]	x[4]	x[4]				
TT-161	Surface Grab (Hold)	1262779.20	217452.50	-28.4	0.5	-28.9	x[4]	x[4]	x[4]	x[4]	x[4]				
TT-162	Surface Grab (Hold)	1262762.85	217745.55	-33.1	0.5	-33.6	x[4]	x[4]	x[4]	x[4]	x[4]				

Notes:
CPT – Cone Penetration Test
FV – Field Vane
1 Target locations actual location will be determined in the field.
2 Conventional analysis includes total solids, grain size, and TOC.
3 SVOCs to be analyzed are PAHs, Pentachlorophenol and Bis(2-ethylhexyl)phthalate.
4 Analyses initially on hold.
5 Seismic CPT to be completed as part of the CPT.

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Legend

- Lockheed West Site
- Harbor Lines
- Pacific Sound Resources Marine Sediment Unit (approximate)
- West Waterway OU (approximate)
- RA5 - Former Shipyard Uplands
- Removal to CSL in Dry Dock Areas
- Dredge to SQS in West Waterway Navigation Channel
- Removal to SQS in Shoreline/Intertidal and Former Shipway Areas
- ENR to Study Area Boundary
- Former Dry Dock Areas
- Habitat Mix
- Riprap Armor Stabilization
- Backfill to Existing Elevations
- Habitat Softening/Enhancement in Existing Riprap Areas
- Remnant Piling Areas (Other Small Areas of Remnant Piling are Excluded)

2007 and Earlier Sampling Locations

- Intertidal Surface Grab
- Subsurface Core
- Surface Grab
- Geotechnical Boring

Proposed Sampling

- Cores to Determine the Volume of Sediment to Remove in the Shipway Piers
- Cores to Refusal to Determine if Accumulated Sediment on the Concrete of the Shipway Requires Removal
- Cores to Determine the Amount of Sediment to be Removed Under the Footprint of the Former Piers
- Cores to Determine the Depth of Removal Required in the Intertidal Area (-10 to 4 feet MLLW)
- Cores to Determine the Depth of Removal Required Along the Shoreline
- Cores to Revisit Prior Sampling Locations to Determine the Depth of Contamination Where Not Achieved and Confirm Presence and Depth of Contamination at Locations with Surface Samples Only
- Core Sample for Geotechnical Testing and Field Vane Test
- Core Sample for Geotechnical Testing and Cone Penetration Test
- Core Sample for Geotechnical Testing and Seismic Cone Penetration Test
- Core Location for Lithology and Geotechnical Test Parameters, Cone Penetration Test and Field Vane Test
- Surface Sediment Grab Sample
- Surface Sediment Grab Sample (for Hold)
- Core Sample for Dewatering Testing

AC = Acre
CSL = Cleanup Screening Level
CY = Cubic Yard
ENR = Enhanced Natural Recovery
SQS = Sediment Quality Standard

Feet
0 125 250 500

Lockheed West Site
Seattle, WA

Figure 2-1: Pre-Design Sampling Outline

Preferred Alternative - 3C Plus, Pre-1998, 2003 and 2007 Sampling Locations

P:\projects_2006\Lockheed\maps\2015_Sampling\Figure_7-1.mxd

2.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Identification and documentation of samples are important in maintaining data quality. Strict custody procedures are necessary to ensure the integrity of the environmental samples. Sample custody must be strictly maintained and carefully documented each time the sample material is collected, transported, received, prepared, and analyzed. The history of each sample and its handling must be documented from its collection through all transfers of custody to ensure the integrity of the sample. A "sample" shall be defined as a piece of physical evidence collected from a facility or the environment. The control of the sample is essential to this evidentiary information. The subsections below address sample identification, custody, and documentation.

2.3.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* field measurements (e.g., water temperature or conductivity) are made, data are recorded directly in logbooks or on field investigation forms. Identifying information such as project name, station number, station location, date and time, name of sampler, field observations and remarks, etc., shall be recorded.

Samples that cannot be analyzed in place must be removed and transported from the sample location to a laboratory or other location for analysis. Each sample collected for off-site laboratory analysis during the field investigation will be specifically designated by TT for unique identification. Information to be recorded on the sample label includes the project name, sample identification number (assigned by TT), sample location, date and time of sample acquisition, type and matrix of sample (including designation of grab or composite), analysis required, preservation (as necessary), and name of sampler.

Sample identification numbers shall be assigned using a data set identifier code (e.g., "TT" for Tetra Tech), a letter code designating the type of sample (e.g., "CS" for chemistry core sample, etc.), a number designating the sample location (e.g., "01" for sample location 1) and the depth interval for the sample (e.g., 00-005 for zero to 0.5 feet and 01-02 for 1 to 2 feet deep).

- CS – core sample
- SS – Surface grab sample
- FV – Field Vane
- CPT – Cone Penetration Test location

2.3.2 Sample Custody

Sample custody must be strictly maintained and carefully documented each time the sample material is collected, transported, received, prepared, and analyzed. Custody procedures are necessary to ensure the integrity of the samples. Samples collected during the field investigation must be traceable from the time the samples are collected until they are disposed of and/or stored at the laboratory.

Field Custody Procedures

The field custody procedures are outlined below. These procedures shall be implemented for each sample collected. The field sampler shall be responsible for the care and custody of the samples until they are properly transferred or dispatched. To assure the integrity of the samples, the samples are to be maintained in a designated, secure area and/or be custody sealed in the appropriate containers prior to shipment. The following procedures should be followed to ensure the integrity of all samples collected.

- All samples should be collected as described in the FSP.
- Sample information should be documented in the field logbook(s) and on field investigation forms (as necessary).
- Sample labels should be completed for each sample using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather) with the information outlined in Section 2.3.2. The sample label should be securely attached to the sample container.
- A chain-of-custody form should be completed, listing all appropriate samples and analyses.

Transfer of Custody and Shipment

The procedures for transfer of sample custody and shipment of samples to the laboratory are outlined below. All samples collected for off-site analysis must follow these procedures.

- Samples shall be accompanied by a completed chain-of-custody record during transport, either supplied by the laboratory or by TT. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This form documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. However, when the chain-of-custody record is sealed inside a cooler and delivered by overnight delivery service (e.g., FedEx), the delivery service will not sign the chain-of-custody record. Evidentiary custody will be demonstrated by the signatures of the sampler and receiving laboratory, along with separate tracking documentation from the overnight delivery service.

- Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate chain-of-custody record accompanying each shipment of coolers. To ensure the integrity of the samples, the samples are to be maintained in a designated, secure area and/or be custody sealed in the appropriate containers prior to shipment. The samples shall be placed in a metal or hard plastic cooler, filled with adequate cushioning material to minimize the possibility of container breakage. Samples are to be packed with sufficient ice to cool the samples to 4°C ± 2°C. Shipping containers will be custody sealed for shipment to the laboratory (as appropriate).

When a courier service is collecting the samples directly from the Site, the chain of custody form shall not be placed inside the cooler. The sample coolers shall be secured with custody seals affixed over the lid opening in at least two locations and the cooler wrapped with strapping tape (without obscuring the custody seals). Orientation "This End Up" arrows shall be drawn or attached on two sides of the cooler. The chain of custody form must be signed by the courier as receiving possession of the samples. Samples shall be transported to the laboratory within 48 hours of sample collection.

When the samples are being shipped by an overnight delivery service to the laboratory, the chain of custody form and any other paperwork shall be placed in a waterproof sealable plastic bag and taped securely to the inside lid of the cooler. The cooler must then be secured, with custody seals affixed over the lid opening in at least two locations, and the cooler wrapped with strapping tape (without obscuring the custody seals). Orientation "This End Up" arrows shall be drawn or attached on two sides of the cooler, and a completed overnight delivery service shipping label shall be attached to the top of the cooler. Wide, clear tape should be used to secure the label to the cooler to prevent the shipping address label from being accidentally peeled off the cooler top. Samples to be shipped by an overnight delivery service shall be shipped within 24 hours of sample collection and arrive at the laboratory within 24 hours of sample shipment. A member of the field team will contact the laboratory to notify them of the sample shipment.

A copy of the chain-of-custody form will be retained by TT in the project files.

Laboratory Custody Procedures

The following list summarizes laboratory custody procedures. More detailed protocols are presented in the specific SOPs.

- A designated sample custodian will accept custody of the shipped samples and will verify that the information on the sample labels matches that on the chain of custody record(s).

- The laboratory custodian will use the sample label number or assign a unique laboratory number to each sample label. The laboratory custodian will also assure that all samples are transferred to the proper analyst or stored in the appropriate secure area.
- Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian or sample storage area. The laboratory shall maintain internal chain of custody records.

The laboratory shall communicate with TT personnel by telephone or electronic mail (email), as necessary, throughout the process of sample scheduling, shipment, analysis, and data reporting, to ensure that samples are properly processed. If a problem occurs during sample shipment or receipt (i.e., a sample container arrives broken or with insufficient sample volume, a sample was not preserved correctly, a sample was not listed on the chain of custody, etc.), the laboratory shall immediately notify the TT designee by telephone or email for resolution. Corrective actions shall be documented and approved before implementation.

When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample and the sample container must be disposed of properly. All identifying tags, data sheets, and laboratory records shall be retained as part of the permanent documentation. Samples received by the laboratory will be retained until analyses and QA checks are completed.

2.3.3 Sample Documentation

Sampling information will be documented in field logbooks, on field forms and where appropriate electronic data collection systems (tablets). The sampling team or any individual performing a particular field investigation activity shall be required to maintain a field logbook. The field logbook shall be a bound weatherproof notebook, and entries to the logbook must be filled out legibly in ink. Pertinent information that will be recorded in field logbooks includes all information that is necessary to reconstruct the investigative/sampling operations. Documentation of sample activities in the field logbook shall be completed immediately after sampling at the location of sample collection. Logbook entries shall contain all sample information, including sample number (and duplicate sample number as applicable), collection time, location, descriptions, field measurements, and other site- or sample-specific observations. Difficulties with sample recovery and field observations (e.g., staining, visible contamination, etc.) must be noted if encountered.

Logbook pages shall be consecutively numbered, and upon entry of data, the logbook pages require the date and the signature of the responsible project team member at the bottom of each page. Corrections to the logbooks shall consist of a single strike line through the incorrect entry, the new accurate information, the initials of the corrector, and the date of amendment. Any blank spaces/pages in the logbooks shall be crossed out with a single strike mark and signed by the person making the notation.

If photographs are taken as part of the documentation procedure, the name of the photographer, the date, the time, the site name, the site location, and a description of the photo shall be entered sequentially in the field logbook as the photographs are taken.

In addition to field logbooks, field team members will use appropriate forms applicable to the field activities (as necessary). Investigation forms may include boring logs, vessel logs, rig shift reports, or calibration/maintenance records. Chain of custody forms shall be used for all sample shipments.

2.4 ANALYTICAL REQUIREMENTS

This section describes the analytical methods that will be used by the laboratory and the method requirements. A sampling and analysis summary is provided in Table 2-2. Specific details for the analytical methods are contained in the laboratory SOPs. Typical laboratory reporting limits for target analytes are specified in Tables 2-3. Only methods listed in this QAPP will be used to analyze project samples, unless prior written approval is obtained from the TT DPM (in conjunction with EPA and Lockheed Martin).

2.4.1 Analytical Methods for Chemical and Physical Testing

Analytical testing of the project samples, as summarized in Table 2-2, will be performed by an analytical laboratory that will be selected prior to sample collection activities. Samples will be analyzed for the target list of analytes identified as contaminants of concern for the site with cleanup levels and remedial action levels (Table 2-3). The samples will be analyzed in accordance with the EPA method requirements as defined in the laboratory-specific SOPs. Laboratories will follow their SOPs for sample preparation, instrument maintenance, instrument calibration, and sample handling.

The project-specific chemical and physical analytical parameters and associated methods to be used by the laboratory are as follows:

- PCB Aroclors – SW846 8082
- PAHs – SW846 8270C-low level
- Pentachlorophenol and bis(2-ethylhexyl)phthalate SVOCs – SW846 8270C
- Total Metals – SW846 6010B-6020, 7471A
- TOC – EPA 415.1/9060/ American Society for Testing and Materials (ASTM) D4129
- Tributyltin – Krone et al. (1989)
- Moisture content – ASTM D2216
- Grain size – PSEP/ASTM D 422 with hydrometer
- Atterberg limits – ASTM D 4318-95
- Organic matter – ASTM D2974-14
- Specific gravity – ASTM D854
- Unit weight – ASTM D7263-09
- Percent solids – EPA Method 160.3
- Total suspended solids – EPA Method 160.2
- Paint filter test – EPA Method 9095B
- Steel corrosion – ASTM E 797/E 797M-10
- Steel tensile strength – ASTM E8 / E8M-15a

2.4.2 Analytical Method Limits of Detection for Chemical, Geotechnical and Physical Testing

Laboratory reporting limits will be similar to the reporting limits listed in Table 2-3. Sediment analytical data results shall be presented either in units of micrograms per kilogram (µg/kg) dry weight (dw) or milligrams per kilogram (mg/kg) dw. Water analytical data will be reported in units of micrograms per liter (µg/L) or milligrams per liter (mg/L). The project goal for sensitivity is to achieve reporting limits that are less than or equal to the Washington Sediment Management Standards (SMS) sediment quality standard (SQS) identified in the Ecology Draft Sediment Cleanup User’s Manual (2015). Per the SMS SQS, results for nonionizable organic compounds will be organic carbon-normalized in order to compare to the sediment criteria listed in the Sediment Cleanup User’s Manual.

2.4.3 Sample Preservation

Samples for the analytical laboratory are to be preserved (which includes ice to 4°C) prior to transportation and storage to prevent or retard degradation or modification of chemicals in the samples. Specified holding times should also be met to maintain the integrity of the sample.

Requirements for the sample containers, preservatives, and holding times to be used during the investigation are provided in Table 2-4. The procedures for the cleanliness of the containers are given in the SOPs of the analytical laboratory.

Table 2-2
Sampling and Analysis Summary for Lockheed West Seattle

Sample Matrix	Laboratory Analysis	No. of Samples[1]	Field QA Samples: Environmental Duplicates	Field QA Samples: Replicates	Field QA Samples: Equipment Blanks	Lab QA Samples: MS/MSD Samples	Total
Sediment							
	Pentachlorophenol, bis(2-ethylhexyl) phthalate, and /PAHs	126	13	12	2	7/7	155
	Pesticides	126	13	12	2	7/7	155
	PCB Aroclors	126	13	12	2	7/7	155
	Total metals	126	13	12	2	7/7	155
	Tributyltin	126	13	12	2	7/7	155
	TOC	126	13	12	NA	NA	139
	Moisture content	165	13	12	NA	NA	178
	Grain size	165	13	NA	NA	NA	178
	Atterberg limits	39	NA	NA	NA	NA	43
	Total suspended solids	9	NA	NA	NA	NA	9
	Specific gravity	3	NA	NA	NA	NA	3
	Unit weight	9	NA	NA	NA	NA	9
	Percent solids	9	NA	NA	NA	NA	9
	Paint filter test	9	NA	NA	NA	NA	9
	Organic matter	3	NA	NA	NA	NA	3
Steel							
	Corrosion	6	NA	NA	NA	NA	6
	Tensile Strength	6	NA	NA	NA	NA	6

[1] Estimated number of samples. Actual number will change during field activities. Additional sediment samples may be archived. The number of environmental duplicates, replicates and MS/MSD samples will be dependent on the number of field samples collected, and shall be analyzed at a rate of 10 percent of samples collected (1 per 10), 5 percent of cores collected (1 per 20 cores) and 5 percent of samples collected (1 per 20) respectively.

Table 2-3. Laboratory Reporting Limits, Method Detection Limits Site Cleanup Levels and Remedial Action Levels

METHOD AND ANALYTE	RL[a] (mg/kg dw)	MDL[a] (mg/kg dw)	Sediment Cleanup Levels (mg/kg dw) [b]	Sediment Remedial Action Level (mg/kg dw) [b]
EPA Method 8270C -low level				
PAHs				
Acenaphthylene	0.02	0.00909	na	na
Benzo(a)anthracene	0.02	0.00834	1.7	1.7
Benzo(a)pyrene	0.02	0.00731	1.5	1.5
Benzo(b)fluoranthene	0.02	0.00734	see total	see total
Benzo(k)fluoranthene	0.02	0.0104	see total	see total
Total benzofluoranthenes [c]	0.02	0.0104	1.8	1.8
Benzo(g,h,i)perylene	0.02	0.00804	0.47	0.47
Chrysene	0.02	0.00809	1.7	1.7
Dibenzo(a,h)anthracene	0.02	0.00835	0.18	0.18
Fluoranthene	0.02	0.00849	2.4	2.4
Indeno(1,2,3-cd)pyrene	0.02	0.00854	0.51	0.51
Phenanthrene	0.02	0.00863	1.5	1.5
Pyrene	0.02	0.00872	na	na
Acenaphthene	0.02	0.00936	0.24	0.24
Anthracene	0.02	0.00869	na	na
Fluorene	0.02	0.00917	na	na
Naphthalene	0.02	0.00753	na	na
2-Methylnaphthalene	0.02	0.00721	na	na
Total LPAHs [d]	0.02	0.00936	na	na
Total HPAHs [e]	0.02	0.0104	14.4	14.4
Total cPAHs [f]	0.02	0.0104	0.009	na
EPA Method 8270C				
Pentachlorophenol				0.36
Bis(2-ethylhexyl)phthalate			0.71	0.71
EPA Method 8082				
Aroclor 1016	0.02	0.00098	see total	see total
Aroclor 1221	0.02	0.00098	see total	see total
Aroclor 1232	0.02	0.00098	see total	see total
Aroclor 1242	0.02	0.00098	see total	see total
Aroclor 1248	0.02	0.00098	see total	see total
Aroclor 1254	0.02	0.00098	see total	see total
Aroclor 1260	0.02	0.00098	see total	see total
Total PCBs [g]	0.02	0.00098	0.002	180
EPA Method 6020 (except as noted)				
Antimony	0.20	0.005	150	na
Arsenic	0.20	0.02	7	57
Cadmium	0.20	0.02	0.398	na
Chromium (EPA 6010B)	0.50	0.09	260	260
Cobalt	0.30	0.03	10	10
Copper (EPA 6010B)	0.20	0.04	114	390
Lead	2.00	0.12	11	530
Nickel	1.00	0.38	140	140
Selenium	5.00	0.3	1	1
Vanadium (EPA 6010B)	0.30	0.03	57	57
Zinc (EPA 6010B)	0.60	0.29	410	410
EPA Method 7471A				
Mercury	0.05	0.003	0.17	0.41

Table 2-3. Laboratory Reporting Limits, Method Detection Limits Site Cleanup Levels and Remedial Action Levels

METHOD AND ANALYTE	RL[a] (mg/kg dw)	MDL[a] (mg/kg dw)	Sediment Cleanup Levels (mg/kg dw) [b]	Sediment Remedial Action Level (mg/kg dw) [b]
TBT Method - Krone 1989				
Di-n-butyltin	0.006	0. 00479	na	na
n-Butyltin	0.006	0.00451	na	na
Tri-n-butyltin	0.006	0.00284	0.15	na
EPA Method Lloyd Kahn				
Total Organic Carbon	200	100	na	na

Footnotes

RL reporting limit

MDL method detection limit

mg/kg dw milligrams per kilogram dry weight

na not applicable

a RLs, MDLs from RI/FS QAPP for Lockheed West Seattle Superfund Site (2008)

b Sediment Cleanup Levels and Remedial Action Levels from Lockheed West Seattle Superfund Site Record of Decision (2013).

c Total benzofluoranthenes is the sum of benzo(b)fluoranthene and benzo(k)fluoranthene. RL and MDL are the highest of the RLs and MDLs for benzo(b)fluoranthene or benzo(k)fluoranthene.

d Total LPAHs is the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. RL and MDL are the highest RL and MDL for the LPAHs. 2-methyl naphthalene is not included in the LPAH definition under the SMS and under the DMMP.

e Total HPAHs is the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene. RL and MDL are the highest RL and MDL for the HPAHs.

f Total PAHs is the sum of the LPAHs and the HPAHs. RL and MDL are the highest RL and MDL for either the LPAHs or HPAHs.

g Total PCBs is the sum of the Aroclors. RL and MDL are the highest RL and MDL for the individual Aroclors.

Table 2-4
Required Containers, Preservatives, and Holding Times

Analysis Type	Matrix	Container Size	Holding Time[1]	Preservation
Pentachlorophenol, bis(2-ethylhexyl) phthalate, and PAHs	Sediment	8 oz glass	14 days extraction/40 days analysis 1 year for extraction if frozen	Ice (4+/- 2ºC) Frozen (-18ºC)
PCBs	Sediment	8 oz glass	14 days extraction/40 days analysis 1 year for extraction if frozen	Ice (4+/- 2ºC) Frozen (-18ºC)
Metals	Sediment	4 oz glass	6 months/28 days[1] 1 year if frozen	Ice (4+/- 2ºC) Frozen (-18ºC)
Tributyltin	Sediment	8 oz glass	14 days extraction/40 days analysis 1 year for extraction if frozen	Ice (4+/- 2ºC) Frozen (-18ºC)
TOC	Sediment	4 oz glass	28 days	Ice (4+/- 2ºC)
Grain size	Sediment	16 oz glass	6 months	Ice (4+/- 2ºC)
SVOCs	Water	One 1-liter amber glass	7 days extraction/40 days analysis	Ice (4+/- 2ºC)
PCBs	Water	One 1-liter amber glass	7 days extraction/40 days analysis	Ice (4+/- 2ºC)
Metals	Water	One 500-mL HDPE	6 months/28 days[1]	Ice (4+/- 2ºC), HNO_3 pH<2
Tributyltin	Water	One 1-liter amber glass	7 days extraction/40 days analysis	Ice (4+/- 2ºC)
Atterberg Limits	Sediment	Inc.	NA	Ice (4+/- 2ºC)

[1] Holding time for mercury is 28 days. Holding time for the other metals is 6 months.
Note: All holding times are from the date of sampling. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis without being qualified.

2.5 QUALITY CONTROL REQUIREMENTS

This section discusses the types and quantities of QA/QC samples to be collected during implementation of the field programs.

2.5.1 Field Quality Control Samples

The subsections below present general information and guidance on field QC samples, including definition and frequency of QC blanks.

Field Sample Duplicates

Field sample duplicates will be analyzed by the analytical laboratory to evaluate the precision and reproducibility of the sampling procedures. Field duplicate samples will be collected at a rate of ten percent of the total samples for each specific matrix for each type of analysis (i.e., one duplicate for up to every 10 samples). The duplicate samples will be collected from the same location and at the same time as the original environmental sample; however, the duplicate samples will be "coded" in such a manner that the laboratory will not be able to determine that the samples are field QC (i.e., "blind" duplicates). An explanation of the duplicate "coding" must be written in the field logbook. Preservation and analysis of duplicate samples will be identical to those for the environmental samples. Precision of field data will be evaluated based on the calculation of RPD between the original and duplicate samples.

Equipment Rinse Blanks

A rinse blank (rinsate) will be collected to evaluate the potential for contamination of environmental samples from inadequate decontamination of field equipment. Rinse blanks shall be collected by pouring contaminant-free deionized water over and/or through either decontaminated equipment (e.g., compositing equipment for sediment sampling) or disposable equipment (e.g., sampling utensils), and collecting the rinsate. One rinse blank will be collected for each type of sampling (i.e., one rinsate blank for surface sampling, one rinsate blank for coring). Preservation and analysis of rinse blanks will be identical to analysis of the associated environmental samples and will follow the guidelines specified in Table 2-4.

2.5.2 Laboratory Quality Control Samples for Chemical Testing

General information and guidance on laboratory QC samples is presented below. A summary of QC procedures, frequencies, criteria, and corrective actions for the samples, as determined by the laboratory SOPs, is provided in Table 2-5. Laboratory internal QC checks will, at a minimum, conform to EPA method-specific QC requirements.

Method Blanks

A method blank will be analyzed with every batch of samples to ensure that contamination has not occurred during the analytical process. These blank samples will consist of a portion of analyte-free solid that is processed through the entire sample procedure the same as an environmental sample. For this project, the laboratory must use either clean sand or sodium sulfate as the matrix for nonaqueous method blanks. These matrices will be subjected to all reagents, surrogates, internal standards, and method protocols to which the environmental samples are subjected.

Matrix Spikes/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) samples will be used to assess precision and accuracy of the analytical methods. In this procedure, two aliquots of an actual field sample are "spiked" by the addition of a known amount of analyte(s) and these samples are then analyzed identically to the field samples. A comparison of the resulting concentration to the original sample concentration and among the two "spiked" sample concentrations provides information on the ability of the analytical procedure to generate an accurate and precise result from the sample. Samples will contain sufficient volume for MS/MSD sample analysis and will be analyzed at a frequency of 5 percent of the total samples. For inorganic analyses, a matrix spike/matrix duplicate may be analyzed in lieu of an MS/MSD set.

Surrogate Compounds

Surrogates (also known as System Monitoring Compounds) are compounds of known concentrations added to every organic analysis sample for analytical chromatography methods at the beginning of the sample preparation to monitor the recovery in regard to sample preparation and analysis. Surrogate recoveries will be used to assess potential matrix interferences and potential problems resulting from sample extraction.

Internal Standards

Internal standards are used to provide instrument correction for variation in instrument performance and injection volumes for some analytical chromatography methods. Internal standards also establish relative response factors for the analytes.

Table 2-5

Summary of Analytical QC Procedure Checks, Frequencies, Acceptance Criteria, and Corrective Actions for Laboratory Sample Analyses

Parameter	Method	QC Procedure	Frequency	Acceptance Criteria	Lab Corrective Action
PCB Aroclors	SW846 80822	ICV/CCV	ICV – following initial calibration CCV – every 20 samples	ICV - %RSD ≤ 20% CCV - ±15% from value average response factors	ICV - Generate new calibration curve for that analyte CCV – Reanalyze CCV. If CCV fails again, generate a new calibration curve.
		Method Blank	1 per batch	no constituent > RL	Correct problem before resuming sample analysis
		MS/MSD	1 per ≤ 20 samples	0 - 30 RPD	Follow method specifications
		QC check sample	At the end of each batch, or 1 per 20 samples, whichever is more frequent	Compound and matrix specific	Correct problem before resuming sample analysis
		LCS	1 per batch	50 – 150 % R	Correct problem before resuming sample analysis
		Surrogate Compounds	all samples	compound and matrix specific	Check calculations and instruments, re-extract and reanalyze affected samples. Allows 1 surrogate out.
Pentachloro-phenol, bis(2-ethylhexyl) phthalate, and PAHs	SW846 8270C/8270C-Low Level	ICV/CCV	ICV – following initial calibration CCV – every 12 hours	ICV – %RSD ≤ 30% CCV – per method SPCC/CCC requirements	ICV – Generate new calibration curve for that analyte CCV – Reanalyze CCV. If CCV fails again, generate a new calibration curve
		Method Blank	1 per ≤ 20 samples	No constituent > RL	Follow method specifications
		MS/MSD	1 per ≤ 20 samples	0 – 30 RPD	Follow method specifications
		MSB	1 per MS/MSD (≤ 20 samples), immediately following the MS/MSD	compound and matrix specific	Follow method specifications
		LCS	1 per batch	50 – 150 % R	Correct problem before resuming sample analysis
		Surrogate Compounds	all samples	compound and matrix specific	Check calculations and instruments, re-extract and reanalyze affected samples if more than one surrogate is out of limits

Table 2-5

Summary of Analytical QC Procedure Checks, Frequencies, Acceptance Criteria, and Corrective Actions for Laboratory Sample Analyses (continued)

Parameter	Method	QC Procedure	Frequency	Acceptance Criteria	Lab Corrective Action
Metals	SW846 6010B, SW846 7471A	ICV/CCV	ICV – following initial calibration CCV – every 10 samples	80 – 120 % R	ICV - Generate new calibration curve for that analyte CCV - Reanalyze CCV. If CCV fails again, generate a new calibration curve
		ICB/CCB	Immediately following the ICV/CCV	no constituent > RL	If the sample concentration of the analyte is < 10 times the blank concentration and above the CRQL, the sample must be redigested and reanalyzed for that analyte
		Preparation Blank	1 per batch (≤ 20 samples)	no constituent > RL	Follow method specifications
		MS/Dup	1 per batch (≤ 20 samples)	< 20% RPD	Follow method specifications
		LCS	1 per batch (≤ 20 samples), immediately following the MS/MSD	75 – 125 %R	Correct the problem and reanalyze all samples prior to the failing LCS
		ICP Interference Check Sample (does not apply to method SW846 7471A)	Beginning and end of each analytical run	+/- 20% of true value	Correct the problem, recalibrate the instrument, reanalyze all samples following the last compliant ICP Interference Check Sample
		Laboratory Duplicate Sample	1 per batch	< 20% RPD for analyte concentrations ≥ 5 times the CRQL; +/- CRQL for analyte concentrations less than 5 times the CRQL	Flag all the data for the samples received associated with that duplicate sample with an asterisk (*)

Table 2-5

Summary of Analytical QC Procedure Checks, Frequencies, Acceptance Criteria, and Corrective Actions for Laboratory Sample Analyses (continued)

Parameter	Method	QC Procedure	Frequency	Acceptance Criteria	Lab Corrective Action
TOC	EPA 415.1	Initial and continuing calibration	Follow method specifications	Follow method specifications	Follow method specifications
		Method Blank	Every 10 samples	No constituent > method MDL	Follow method specifications
		MS/MSD	1 per batch (≤ 20 samples)	< 20% RPD	Follow method specifications
		LCS	1 per batch (≤ 20 samples), immediately following the MS/MSD	80 – 120 %R	Follow method specifications
Grain Size	ASTM D 422 with hydrometer	Laboratory Duplicate Sample	1 per batch	< 20% RPD for analyte concentrations ≥ 5 times the CRQL; +/- CRQL for analyte concentrations less than 5 times the CRQL	Flag all the data for the samples received associated with that duplicate sample with an asterisk (*)
Atterberg Limits	ASTM D 4318-95	Laboratory Duplicate Sample	1 per batch	< 20% RPD for analyte concentrations ≥ 5 times the CRQL; +/- CRQL for analyte concentrations less than 5 times the CRQL	Flag all the data for the samples received associated with that duplicate sample with an asterisk (*)

ASTM = American Society for Testing and Materials
ICV = Initial Calibration Verification
CCV = Continuing Calibration Verification
MS/MSD = matrix spike/matrix spike duplicate
MSB = matrix spike blank
QC = Quality Control

LCS = Laboratory Control Sample
CRQL = Contract Required Quantitation Limit
RPD = relative percent difference
CCC = calibration check compound
SPCC = system performance check compounds
MDL = method detection limit

Laboratory Control Sample

Data from the laboratory control sample (LCS) are used to monitor laboratory accuracy of a particular analytical method and to monitor laboratory performance. Generally, one LCS is analyzed per analytical batch. The LCS is an aliquot of reagent water or clean solid material (e.g., sand or sodium sulfate) spiked with the analytes as determined by the method. The LCS percent recoveries are used to evaluate the accuracy of the extraction and analysis procedures.

2.6 INSTRUMENT CALIBRATION AND FREQUENCY

This section describes the requirements for control, calibration, adjustment (if necessary) and preventive maintenance of instrumentation. Instruments shall be calibrated and adjusted (if warranted) at specified, predetermined intervals using known, recognized standards. All instruments shall be calibrated and maintained in accordance with manufacturer’s instructions.

2.6.1 Field Instrumentation

Calibration

The FSL or designee will be responsible for ensuring that instrumentation is of the proper range, type, and accuracy for the test being performed. The FSL should also verify that all of the equipment is calibrated at their required frequencies, according to their specific calibration protocols/procedures.

All field measurement instruments must be calibrated according to the manufacturer’s instructions prior to the commencement of the day’s activities. Exceptions to this requirement shall be permitted only for instruments that have fixed calibrations pre-set by the equipment manufacturer. Calibration information shall be documented on instrument calibration and maintenance log sheets or in a designated field logbook. Information to be recorded includes the date, the operator, and the calibration standards (concentration, manufacturer, lot number, expiration date, etc.). All project personnel using measuring equipment or instruments in the field shall be trained in the calibration and usage of the equipment, and are personally responsible for ensuring that the equipment has been properly calibrated prior to its use.

In addition, all field instruments must undergo response verification checks at the end of the day’s activities and at any other time that the user suspects or detects anomalies in the data being generated. The checks consist of exposing the instrument to a known source of analyte (e.g., the calibration solution), and verifying a response. If an unacceptable instrument response is obtained during the check (i.e., not within specifications), the data shall be labeled suspect, the problem documented in the site logbook, and appropriate corrective action taken.

Any equipment found to be out of calibration, shall be re-calibrated. When instrumentation is found to be out of calibration or damaged, an evaluation shall be made to ascertain the validity of previous test results since the last calibration check. If it is necessary to ensure the acceptability of suspect items, the originally required tests shall be repeated (if possible) using properly calibrated equipment. Any instrument consistently found to be out of calibration shall be repaired or replaced.

Maintenance

Field equipment shall be maintained at its proper functional status in accordance to manufacturer manual specifications. A check of the equipment shall be performed before field activities begin, and any potential spare parts (e.g., batteries, connectors, etc.) and maintenance tools will be brought on site to minimize equipment downtime during the field activities. Visual checks of the equipment will be conducted on a daily basis. Routine preventive maintenance shall be performed to assure proper operation of the equipment. Any maintenance performed on field equipment will be documented on instrument calibration and maintenance sheets or in the designated field logbook, and shall be undertaken only by personnel who have the appropriate skills and/or training in the type of maintenance required.

2.6.2 Laboratory Instrumentation

Calibration

Personnel at the laboratory will be responsible for ensuring that analytical instrumentation are of the proper range, type, and accuracy for the test being performed, and that all of the equipment are calibrated at their required frequencies, according to specific laboratory SOPs.

Laboratory equipment shall be calibrated using certified/nationally recognized standards and according to the laboratory SOPs. In addition, these methods/procedures specify the appropriate operations to follow during calibration or when any instrument is found to be out of calibration.

Maintenance

The laboratory is responsible for the maintenance of their analytical equipment, in accordance with manufacturers' specifications. Analytical personnel will be responsible for ensuring that instrumentation is functioning properly and within specific guidelines/specifications prior to starting any analysis. Maintenance, performed by either laboratory personnel or the manufacturer's service personnel, will be conducted according to the manufacturer's recommendations and procedures.

2.7 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Supplies and consumables necessary for the field investigation will be obtained through appropriate commercial markets and shall meet any supply-specific requirements outlined in this QAPP. All supplies and consumables will be inspected by TT personnel (e.g., the FSL or the QA Manager) prior to use. Any supplies/consumables that do not meet requirements will be discarded or returned to the supplier.

Supply-specific requirements include the following:

- Sampling equipment shall be manufactured from the procedural-specific material.
- Sample bottle containers will be provided by the subcontractor laboratory.
- Certifications from the supplier of the "cleanliness" of the bottles must be provided to TT by the laboratory and retained in the project files.

Supplies and consumables will be stored, as necessary, in a designated area on the site. The storage area shall be protected from adverse conditions (e.g., weather, heat, etc.) to protect the supplies/consumables from possible outside contamination and breakage.

2.8 DATA MANAGEMENT

Standard methods and references will be used as guidelines for data handling, reduction, validation, and reporting. All data for the project will be compiled and summarized with an independent verification at each step in the process to prevent transcription/typographical errors. Any computerized entry of data will also undergo verification review.

2.8.1 Field Data

Field instrumentation data will be reported by site personnel in field logbooks and/or on field investigation forms associated with the sampling event.

2.8.2 Laboratory Data

The analytical laboratory will tabulate and compile analytical results and associated QA/QC information according to method procedures. All data generated by the laboratory will be reported in appropriate formats and concentration units consistent with standard EPA procedures and this project QAPP. Laboratory QA/QC information required by the method protocols will be compiled, including the application of data QA/QC qualifiers as appropriate. In addition, laboratory worksheets, laboratory notebooks, sample tracking system forms, chains-of-custody forms, instrument logs, and calibration records, as applicable, will be provided in the laboratory data packages to determine the validity of data. Specifics on internal laboratory data reduction protocols are identified in the laboratory's quality assurance plan or SOPs.

2.8.3 Project Data Reduction

Following receipt of the laboratory analytical results by TT, the data will be validated. The results will be compiled in a relational database for evaluation and presentation in an appropriate tabular form. Where appropriate, the impacts of QA/QC qualifiers resulting from laboratory or external validation reviews will be assessed in terms of data usability. At this time, the QA/QC qualifiers will be added to the project database. Data will be reported to two significant figures.

Replicates and Multiple Results

Samples in which multiple results for a target analyte are reported by the laboratory may be due to dilution or when a sample is reanalyzed due to QC sample results not within acceptance criteria. In these cases, the laboratory may report all results. After the data qualifiers are applied during the data validation process, Tetra Tech will review the results to select the appropriate result and assign one valid result per target analyte per sample. Following are the guiding principles that will be applied when selecting the result that will be used when multiple results were reported:

1. When multiple results indicated the analyte was not detected, the lowest reporting limit for a non-detect analyte will be selected.
2. When one result is rejected (R) during validation, the remaining result will be selected.

3. When one result indicates a detection and the other result is not detected, the detected value will be selected.

Field split samples will be reported as individual samples in the data report tables. Laboratory QC samples such as duplicates will not be reported as a sample result but treated as a QC sample only.

Calculating Totals

Total PCBs, Total HPAH, Total LPAH, Total Benzofluoranthenes, and Total PAH will be calculated using Sediment Management Standards Chapter 173-204 WAC.

Total PCBs will be calculated using only detected values for seven Aroclor mixtures. For individual samples in which none of the seven Aroclor mixtures are detected, total PCBs will be given a value equal to the highest reporting limit of the seven Aroclors and assigned a "U" qualifier indicating the lack of detected concentrations.

Total LPAHs are the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Total HPAHs are the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Total benzofluoranthenes are the sum of the b (i.e., benzo(b)fluoranthene), j, and k isomers. Because the j isomer is rarely quantitated, this sum is typically calculated with only the b and k isomers. For samples in which all individual compounds within any of the three groups described above are undetected, the single highest reporting limit for that sample represents the sum.

2.8.4 Non-Direct Measurements

If information necessary for the project has not been measured directly in the field, non-direct measurement data may be obtained from literature files, texts, computer databases, etc. References utilized will be acknowledged sources within the specific discipline. An explanation of the rationale behind using the reference and a description of any concern on using the reference data (e.g., uncertainty, conflicting literature, etc.) shall be documented. Non-direct measurement data, after usage, will be filed within the project files for the length of the project.

2.8.5 Data Usage

The data generated in the field, laboratory, and/or office will be used to satisfy the individual task requirements. The specific equations and the calculations that are used to reduce the data in the acceptable format will be described and documented, as appropriate.

Section 3
Assessment/Oversight

3.1 ASSESSMENT AND RESPONSE ACTIONS

Assessment activities will be conducted throughout the project to ensure compliance with the QAPP. The TT DPM and/or FSL will conduct a "readiness review" for field activities prior to the commencement of the investigation. Equipment and supplies will be inventoried, and field instrumentation will be checked to ensure that all are in working order. Any maintenance activities performed during the "readiness review" are to be documented on instrument maintenance sheets or in a designated field logbook. During the sampling activities, the FSL will be responsible for auditing field activities to ensure conformance to the FSP. Auditing activities will include examination of field sampling records, field instrument operating records, sample collection, handling and transport in compliance with the established procedures, adherence to QA procedures, and appropriate chemical of concern procedures.

Nonconformances identified during audits will generate a nonconformance report or a need for corrective action. These issues will be addresses by the QA manager prior to continuing work. Audits will be conducted, as needed, based on the significance of work activities, level of quality required to meet project objectives, and status of nonconformances or corrective actions previously identified.

Internal laboratory audits will be conducted by the laboratory QA department in accordance with the laboratory's specific QAPP. The analytical laboratories used for this project will be assessed according to standard laboratory audit procedures and internal laboratory QA requirements. Internal systems and performance audits will be conducted by the analytical laboratories in accordance with the laboratory SOPs. These audits are typically conducted at several levels. From the laboratories, they shall cooperate with regulatory agency personnel with Agency-requested internal technical systems and/or performance audits. Surveillance of field program activities will be conducted by the DPM and FOL. External laboratory audits may be conducted by the EPA or other oversight agencies at their discretion.

3.2 REPORTS TO MANAGEMENT

3.2.1 Contents of Laboratory Data Reports

The results of the laboratory analyses will be reported to the TT DPM in a hardcopy report and in an electronic format. The hardcopy report shall consist of a fully data validatable package. The hardcopy laboratory report will contain information such as:

- Title and location of the project
- Project identification number
- Name of the report
- Date report was prepared
- Name, address and telephone number of the laboratory
- Case narrative (noting any problems encountered in receipt or during analysis of the samples, and the corrective actions utilized including telephone logs, etc.)
- Sample identification number
- Name and location of sample
- Type of sample (e.g., water, sediment)
- Analysis performed
- Parameter results
- Any special observations, circumstances, or comments that may be relevant for interpretation of the data
- Signature of laboratory manager

Each laboratory report will also include supporting documentation, such as copies of chromatograms, data system printouts, laboratory QC sample recoveries and RPDs, surrogate recoveries, data flags, instrument and extraction blank results, check standard recoveries, initial calibration data, internal sample tracking documentation, sample preparation and analysis logbooks, and standard preparation data, as appropriate. Each constituent tested will include the name of parameter, approved testing procedure references, results of analysis, and the units of the reported results. The sample data results shall also be submitted in standard electronic data format within the project-specific turnaround time.

The electronic data report will be provided in Access or EIM format and will include at a minimum data in the following fields:

- Laboratory sample number
- Project sample identification
- Sample collection date
- Preparation method
- Analytical method
- Analyte (Parameter)
- Analyte (Parameter) CAS number
- Flagging field associated with sample concentration
- Method detection limit
- Method reporting limit
- Sample-specific reporting limit
- Sample concentration
- Units
- Qualifier code
- Sample analysis date
- Sample matrix
- Result basis (wet/dry)
- Laboratory Identification

3.2.2 Contents of Data Validation Reports

The chemistry analytical data in support of this project will be validated by a third-party independent data validation firm. The data validation subcontractor will prepare a data validation report. The data validation report will provide a thorough evaluation of the analytical data and will determine whether or not the data meets the project-specific criteria for data quality. The report will include a list of samples associated with the report, a discussion of quality issues of concern, a summary of sample result qualifications due to validation, and the signature of the validator.

3.2.3 Contents of Management Reports

The TT DPM will provide weekly progress updates to Lockheed Martin members by telephone. Following sampling activities, TT will provide to Lockheed Martin reports summarizing all data collected in the field, followed by a report summarizing all sampling activities. Additional reports required for this project include a report containing the analytical results from sampling and a validation report.

Section 4
Data Validation and Usability

4.1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

A Stage 2 B validation of the analytical data shall be completed on 100 percent of the samples. Validation will be performed by a qualified independent validator in accordance with the National Functional Guidelines for Inorganic Data Review (EPA, 2010) and National Functional Guidelines for Organic Data Review (EPA, 2008). Analytical data validation will include a systematic review of the analytical data package for compliance with the established QC criteria. The validation will consider aspects such as proper laboratory sample handling, conformance to method requirements, acceptable QC sample results, and proper final data reporting. During data validation, any outstanding data issues will be resolved to determine the certainty with which data may be used in making project decisions. Results of the data review process will be used to determine whether to accept, reject, or qualify the analytical results.

The analytical laboratory will perform in-house analytical data reduction and data QA review prior to releasing the data to TT. The purpose of the review is to ensure that the analysis was performed correctly and that the results were reported correctly. The laboratory review will consider data comparability, integrity, and attainment of QC criteria as outlined in laboratory SOPs, established in EPA methods, or described in this QAPP. Laboratory reviews are typically conducted at several levels within the laboratory. The initial review is the responsibility of the analyst generating the data. The section manager may conduct a second level review. Finally, the laboratory QA manager will complete a thorough audit of reports at a specified frequency and will review all final reports for consistency and clarity of presentation. The laboratory QA manager will decide whether any sample reanalysis is required and on the approach for any corrective actions. The laboratory QA manager is responsible for assessing data quality and documenting any data that are considered "preliminary" or "unacceptable" or that would caution the data user of possible unreliability.

Qualifiers (as applicable) will be added to the project database by manual computer entry. All keyed entries will be verified and signed off as checked by the QA Manager or his designee.

4.2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data validation and usability are evaluated to determine whether or not project data conform to specified criteria and satisfy project DQOs. This process involves evaluating the project data with respect to the DQOs and resolving any outstanding data issues to determine the certainty with which data may be used in making project decisions. Data not meeting the DQO criteria may be classified as screening (or characterization) data and used to provide additional information for the project, but it may not be used in the decision-making process.

Review and implementation of systems and procedures may result in recommendations for corrective action. Any deviations from the specified procedures within approved project plans due to unexpected site-specific conditions shall warrant corrective action. All errors, deficiencies, or other problems shall be brought to the immediate attention of the TT PM, who in turn shall contact the TT QA Manager or his designee (if applicable).

Procedures have been established to ensure that conditions adverse to data quality are promptly investigated, evaluated, and corrected. The procedures for review and implementation of a corrective action include the following:

- Define the problem
- Investigate the cause of the problem
- Develop a corrective action to eliminate the problem, in consultation with the personnel who defined the problem and who will implement the change
- Complete the required form describing the change and its rationale (see below for form requirements)
- Obtain all required written approvals
- Implement the corrective action
- Verify that the change has eliminated the problem

If any problems occur with the laboratory or analyses, the laboratory must immediately notify the TT designee. Corrective actions must be documented in writing (e.g., on telephone contact log sheets or by email), which shall become part of the written narrative of the final data report.

During the field investigation, all changes to the sampling program must be documented on a FCR form. FCRs shall be numbered serially, starting with the number "01." A copy of the FCR must be maintained at the site and in the project management files.

All corrective action documentation and FCRs shall include an explanation of the problem and a proposed solution. Each report must be approved by the necessary personnel (e.g., the TT PM, the Lockheed Martin Project Manager) before implementation of the change occurs. At a minimum, copies of the approved FCR form will be distributed to the TT DPM, the FSL, the QA Manager (as applicable), and the project files. A typical distribution list is provided at the bottom of the form. The TT DPM shall be responsible for the controlling, tracking, implementing, and distributing of all identified changes/forms.

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Section 5
REFERENCES

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ATTACHMENT 1
Laboratory
Quality Assurance Manual

(To be provided with Final)

ATTACHMENT 2

Laboratory
Method Precision/Accuracy Objectives

(To be provided with Final)

APPENDIX C— HEALTH AND SAFETY PLAN

Appendix C

Health and Safety Plan
Lockheed West Seattle Superfund Site
Seattle, WA

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

September 21, 2015

Revision 1

APPROVALS

This Health and Safety Plan (HASP) was prepared for the Pre-Design field activities at the Lockheed West Seattle Superfund Site, Seattle, Washington. The purpose of this HASP to identify the scope of work, personnel, and health and safety requirements for the successful and safe completion of the project. By their signature, the undersigned certify that this HASP will be utilized for the protection of the health and safety of personnel during fieldwork conducted at the Lockheed West Seattle Superfund Site, Seattle, Washington.

_________________________________ _____________

Project Manager Date
Gary Braun

_________________________________ _____________

Site Safety and Health Officer Date
Jennifer Kraus

_________________________________ _____________

Project Environmental and Safety Manager Date
Tami Froelich

TETRA TECH, INCORPORATED, TETRA TECH SUBCONTRACTORS, AND THE CLIENT DO NOT GUARANTEE THE HEALTH OR SAFETY OF ANY PERSON ENTERING THIS SITE. DUE TO THE NATURE OF THIS SITE AND THE ACTIVITY OCCURRING THEREON, IT IS NOT POSSIBLE TO DISCOVER, EVALUATE, AND PROVIDE PROTECTION FOR ALL POSSIBLE HAZARDS THAT MAY BE ENCOUNTERED. STRICT ADHERENCE TO THE HEALTH AND SAFETY GUIDELINES SET FORTH HEREIN WILL REDUCE, BUT NOT ELIMINATE, THE POTENTIAL FOR INJURY AT THIS SITE. THE HEALTH AND SAFETY GUIDELINES IN THIS PLAN WERE PREPARED SPECIFICALLY FOR THIS SITE AND SHOULD NOT BE USED ON ANY OTHER SITE WITHOUT PRIOR RESEARCH AND EVALUATION BY TRAINED HEALTH AND SAFETY SPECIALISTS

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ACRONYMS

AHA	Activity Hazard Analysis
CFR	Code of Federal Regulations
Coast Guard	U.S. Coast Guard
COC	contaminant of concern
CPT	cone penetrometer testing
CRZ	contamination reduction zone
dBA	A-weighted decibel
DNR	Washington Department of Natural Resources
DPM	Design Project Manager
EPA	U.S. Environmental Protection Agency
EZ	exclusion zone
FSL	Field Sampling Lead
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
Lockheed Martin	Lockheed Martin Corporation
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
mg/m^3	milligrams per cubic meter
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
PESM	Project Environmental and Safety Manager
Port	Port of Seattle
PPE	personal protective equipment
ppm	parts per million
Site	Lockheed West Seattle Superfund Site

SSHO	Site Safety and Health Officer
STEL	short-term exposure limit
TBT	Tributyltin
TWA	time-weighted average

Section 1
Background and Introduction

This Health and Safety Plan (HASP) addresses health and safety practices and controls that will be implemented by Tetra Tech, Inc. (Tetra Tech) and its subcontractors during the environmental sampling (water and sediment) associated with field activities at the Lockheed West Seattle (also formerly known as Lockheed Shipyard Number 2) Superfund Site, Seattle, Washington (the Site).

Activities performed under this HASP will comply with applicable sections of 29 Code of Federal Regulations (CFR) 1910 and 1926. Any modifications to the HASP will be reviewed and approved by the Project Environmental and Safety Manager (PESM) and the client's project manager. The HASP and its attachments provide the minimum health and safety requirements for on-site personnel. Each company that participates in the field activities has the responsibility to review the original HASP and any HASP revision, and adhere to the requirements therein.

1.1 DISTRIBUTION AND APPROVAL

The HASP will be made available to all Tetra Tech personnel involved in fieldwork on this project. It will also be made available to subcontractors and other non-employees who may need to work on the Site. For all employees, it must be made clear the plan represents minimum safety procedures. They must also understand they are responsible for their own safety while present on the Site. A safety briefing covering aspects of the HASP will be made to all employees, and daily safety briefings will be made for the entire field crew. The plan has been approved by Tetra Tech's PESM. By signing the documentation form provided with this plan (Section 12 located at the end of plan), project workers also certify their understanding and agreement to comply with the plan.

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Section 2
Description of Project

The following sections briefly describe the project history, location, and scope of work to be completed at the Site.

2.1 PROJECT HISTORY AND SUMMARY

The Site is located in the southwest corner of Elliott Bay, and consists of the aerial extent of sediment contamination and sources thereto from the former shipyard facility also known as Lockheed Shipyard Number 2, which was located at 2330 Southwest Florida Street in West Seattle, Washington.

The Site is located near the confluence of the West Waterway and Elliott Bay, in Seattle, Washington (Figure 2-1). The Site is bordered by Elliott Bay on the north, the Harbor Island West Waterway Operable Unit on the east, Pacific Sound Resources Marine Sediment Unit on the west, and the Port of Seattle (Port) Terminal 5 to the south. The Site includes the in-water marine sediments where the former Lockheed Shipyard Number 2 was located (the shipway and dry docks were located in the water over the sediments). The Site is impacted by tides with additional influence from the Lower Duwamish Waterway (LDW) that flows into the West Waterway. The Site also includes a narrow shoreline bank defined as areas extending from plus [+] 11.3 feet mean higher high water (MHHW) to intertidal sediments (exposed by low tides) at minus [-] 10 feet mean lower low water (MLLW) along the northern and eastern shorelines, as well as subtidal sediments (never exposed by low tides) that extend to -40 to -50 feet (MLLW) in historically dredged areas. Numerous pilings remain within the footprint of the former shipway and pier structures in the northwestern portion of the Site. In total, the Site encompasses 40 acres of aquatic lands, including approximately 33 acres of state-owned aquatic lands managed by the Washington State Department of Natural Resources and 7 acres of Port-owned aquatic tidelands. Lockheed Martin Corporation (Lockheed Martin) discontinued operations at Lockheed Shipyard Number 2 in 1987 after approximately 41 years of continuous operations that included shipbuilding, ship repair, and ship maintenance. Past industrial practices at or adjacent to the facility have resulted in contamination of upland soils and adjacent aquatic sediments. The contaminants found in the aquatic area include hazardous substances commonly associated with shipbuilding, repair, and maintenance activities, consistent with the historical uses of the facility. Contaminants of concern (COCs) at the Site include the risk drivers, which are polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), mercury, other metals, and organic compounds. The complete list of COCs is included in Attachment A.

2.2 ENVIRONMENTAL SETTING

The aquatic area associated with the Site is located along the southwestern shoreline of Elliot Bay, adjacent to the Port's container shipping operations at Terminal 5 (Figure 2-1). A portion of the aquatic area also borders the West Waterway of the Duwamish River. For the purposes of this HASP, offshore areas of the former shipyard include:

- Approximately 33 acres of subtidal state-owned aquatic land, managed by the Washington State Department of Natural Resources (DNR) (20 acres were previously leased from DNR), and
- Approximately 7 acres of aquatic land south of the former DNR lease areas that are owned by the Port.

The southern edge of the Site is defined for this report as the top of the bank along the shoreline adjacent to Terminal 5. The Port completed extensive redevelopment and environmental remediation of upland areas at Terminal 5 in the late 1990s. Terminal 5 is currently used for container shipping.

2.3 SCOPE OF WORK

The scope of work to be conducted in the field is discussed in detail in Section 4 and includes the following:

- Mobilization to the Site;
- Sediment core collection (off-shore) for chemical sampling with a barge mounted drill rig (i.e., hollow-stem auger or sonic);
- Collection of cone penetrometer testing (CPT) data in subtidal and uplands areas;
- Sediment sampling in inter-tidal area using hand-held coring equipment;

- Sediment core collection (off-shore) for chemical sampling using a vibracore system in the shipway piling area and in shallow water areas;
- Sediment surface collection (off-shore) for chemical sampling using a van Veen grab sampler;
- Shoreline poling to assess the extent of rip rap;
- Marine surveys (Bathymetric and magnetometer);
- Weekly surveys of on-water activities in the Site area and the Lower Duwamish Waterway; and
- Demobilization from the Site.

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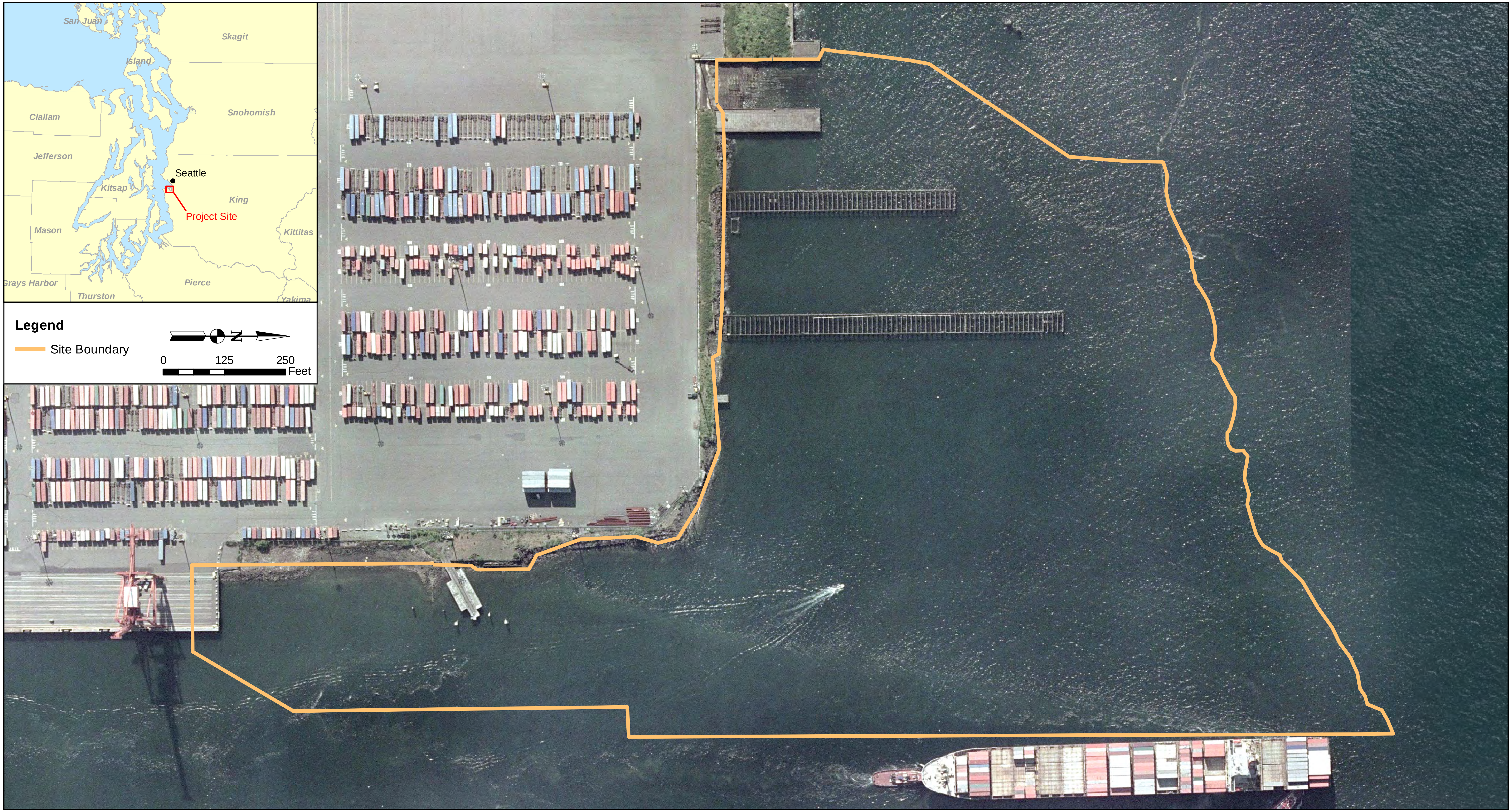

TETRA TECH

Lockheed West
Seattle, WA

Figure 2-1
Location of Lockheed West
Seattle, WA

Section 3

Organizational Structure and Responsibilities

The following sections specify Tetra Tech's project organization and chain of command for health and safety on this project.

3.1 DESIGN PROJECT MANAGER

Mr. Gary Braun is the Design Project Manager (DPM) for this project. His responsibilities include the following:

- Ensures implementation of this program and coordinates with the responsible PESM,
- Participates in major incident investigations,
- Ensures the HASP has all of the required approvals before any site work is conducted,
- Ensures the PESM and Site Safety and Health Officer (SSHO) are informed of project changes that require modifications of the site safety plan,
- Has overall project responsibility for project health and safety, and
- Ensures adequate personnel and equipment are available to safely complete the project.

3.2 FIELD SAMPLING LEAD

Jennifer Kraus is the Field Sampling Lead (FSL) for this project. Her responsibilities include the following:

- Ensures the HASP is implemented,
- Ensures field work is scheduled with adequate personnel and equipment resources to complete the job safely,
- Enforces site health and safety rules,
- Investigates incidents,
- Ensures the PESM and SSHO are informed of project changes that require modifications to the HASP,

- Ensures proper personal protective equipment is utilized,
- Ensures project personnel have appropriate training and experience to do the work,
- Assigns work and monitors performance, and
- Communicates all pertinent health and safety and regulatory compliance issues to the client.

3.3 SITE SAFETY AND HEALTH OFFICER

Jennifer Kraus is the SSHO for this project. Her responsibilities include the following:

- Ensuring that team members understand the requirements of the HASP policies and procedures through training and communications;
- Conducting daily health and safety briefings;
- Exercising stop work authority when warranted by conditions, in accordance with the project plans;
- Ensuring that site personnel have received required EHS regulatory and program training;
- Supporting the FSL, pre-design Investigation lead, and the DPM in accident and incident investigations:
    - Acts as Emergency Coordinator,
    - Notifies PESM and DPM of all accidents/incidents,
    - Investigates incidents, and
    - Assists FSL in incident investigations;
- Functioning as a technical resource for all environmental, safety, loss, industrial, and hygiene issues; and
- Ensuring that the specific responsibilities in the HASP are implemented:
    - Evaluates the adequacy of personnel and equipment resources to complete the job safely,
    - Helps enforce site health and safety rules,
    - Ensures the PESM is informed of project changes that require modifications to the HASP,
    - Ensures proper personal protective equipment is utilized,

- Inspects personal protective equipment (PPE) to ensure PPE is adequate and not resulting in employee exposure, and
- Reports to PESM and DPM to provide summaries of field operations and progress.

3.4 PROJECT ENVIRONMENTAL AND SAFETY MANAGER

Ms. Tami Froelich is the PESM for this project. Her responsibilities include the following:

- Provides for the development and approval of the HASP,
- Serves as the primary contact to review health and safety matters that may arise,
- Approves revised or new safety protocols for field operations,
- Approves individuals who are assigned site safety responsibilities,
- Coordinates revisions of this HASP with field personnel,
- Coordinates upgrading or downgrading of PPE with the FSL/SSHO, and
- Assists in the investigation of high loss incidents, including near misses.

3.5 SITE PERSONNEL

The following responsibilities pertain to all site personnel:

- Report any unsafe or potentially hazardous conditions to the FSL/SSHO;
- Maintain knowledge of the information, instructions, and emergency response actions contained in the HASP;
- Comply with rules, regulations, and procedures as set forth in this HASP and any revisions;
- Prevent admittance to work sites by unauthorized personnel; and
- Prior to use, daily inspect all tools and equipment, including PPE.

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Section 4
Comprehensive Work Plan

The scope of work to be conducted includes the following activities:

- Site mobilization and demobilization,
- Subsurface sediment sampling from a boat or barge mounted drill rig,
- Sediment coring in the inter-tidal zone,
- Surface sediment sampling,
- Sediment core processing,
- Geotechnical CPT,
- Uplands drilling for soil samples,
- Shoreline poling to assess the extent of rip rap,
- Marine surveys (bathymetric and magnetometer), and
- Weekly surveys of on-water activities in Yard 2 area and the Lower Duwamish River.

In general, sediment samples will be collected from the back of the vessel using a vibracore or barge mounted drill rig. Sediment cores collected using a vibracore will be capped and transported to an on-shore processing area, where the cores will be logged and sampled, or cut and sent off for analyses. Sediment cores from the inter-tidal zone will be collected using a hand-held coring device, transported to the on-shore processing area, logged, and sampled. Activities are described in greater detail in the following sections.

4.1 SITE MOBILIZATION AND DEMOBILIZATION

Mobilization and demobilization includes moving and removing necessary heavy equipment and personnel to and from the Site to perform the scope of work. Physical hazards associated with mobilization and demobilization activities are typically limited to general construction hazards such as slips, trips, and falls onto the vessel decking and/or into the water; material lifting and handling; and use of heavy equipment.

4.2 SUBSURFACE SEDIMENT SAMPLING FROM BOAT OR DRILL RIG

Sediment cores are collected using a vibracore sampler or drill rig. A vibracore sampler consists of an aluminum or stainless steel tube connected to an oscillating vibratory head that is lowered through the water column into the sediment. If possible, the core tube is lowered directly through the sediment under its own weight. If necessary, the electronic vibratory head is activated and sends a vibration through the aluminum tube aiding it in passing through the sediment. A catcher at the bottom of the tube causes the sediment to be retained within, and the tube is brought back to the deck of the vessel where it is logged, and sampled. Physical hazards associated with sediment surface and core sampling include those associated with boating safety including accidents with other boats, lifting of heavy equipment, and operation of electrical equipment. Chemical hazards include those associated with contact with potentially impacted sediment and are identified by chemical in Section 5.

In addition, a barge mounted drill rig (i.e., hollow-stem auger or sonic) will be used for environmental and geotechnical sample collection. This approach will consist of driving the drill rig onto a barge and drilling through a “moon hole” on the deck of the barge or off the back of the barge. The barge will be driven to the sample location and secured using spuds driven into the sediment in shallow water or anchors in deeper water. The drill rig will then be used to collect the sediment sample increments in the same manner as the drill rig would be used on shore. Physical hazards include those typically associated with drill rigs, such as contact with moving/rotating machinery, lifting of heavy objects, contact with overhead utilities, risk of spills of hydraulic fluids, and increased noise levels. Chemical hazards include those associated with contact with potentially impacted sediment and are identified by chemical in Section 5.

4.3 SEDIMENT CORE COLLECTION – INTER-TIDAL ZONE

Sediment cores will be collected from the inter-tidal zone using hand-held equipment or a small vibracore during low tide conditions. Sampling equipment will include a hand-held coring device that is pushed into the sediment or a small portable vibracore system if adequate penetration into the sediment is not achieved using hand-held equipment. Physical hazards associated with inter-tidal sampling include slips, trips, and falls onto the vessel decking and/or into the water, associated with work done on slick surfaces with potential unsure footings. Chemical hazards include those associated with contact with potentially impacted sediment and are identified by chemical in Section 5.

4.4 SURFACE SEDIMENT SAMPLING

Surface sediment samples will be collected from the vessel using a van Veen sampler. The sampler is a clam-shell device that is lowered through the water column into the sediment. The sampler closes and collects sediment that is brought to the surface where it is visually characterized and samples are collected. Physical hazards associated with sediment surface sampling include those associated with boating safety including accidents with other boats, lifting of heavy equipment, and operation of equipment that presents pinch-point hazards. Chemical hazards include those associated with contact with potentially impacted sediment and are identified by chemical in Section 5.

4.5 SEDIMENT CORE PROCESSING

Sediment cores will be processed on-shore. The exact location of the on-shore processing area is not known at this time as an agreement has not been reached with the client and the current tenant at the Site. It is anticipated that the processing area will be located near the north side of Terminal 5, likely in the same area as was used during the remedial investigation sampling. The risks associated with core processing will be re-evaluated if the processing area is located in a different area. Physical hazards include lifting of heavy objects when placing the cores on the processing table and use of hand tools to cut cores. Chemical hazards include those associated with contact with potentially impacted sediment and are identified by chemical in Section 5.

4.6 UPLANDS SOIL SAMPLING WITH DRILL RIG

Upland soil samples are collected using a drill rig (hollow-stem auger with split spoon sampler). Physical hazards include those typically associated with drill rigs, such as contact with moving/rotating machinery, lifting of heavy objects, contact with overhead utilities, spills of hydraulic fluids, and increased noise levels. Chemical hazards include those associated with contact with potentially impacted sediment and are identified by chemical in Section 5.

4.7 GEOPHYSICAL CONE PENETRATION TEST

The barge mounted drill rig (i.e., hollow-stem auger or sonic) will be used for geotechnical CPT in the subtidal areas. The advancement of the CPT will be performed along with the uplands drilling and barge-mounted sediment core collection using the drill rig to advance the CPT tip. Physical hazards include those typically associated with drill rigs, such as contact with moving/rotating machinery, lifting of heavy objects, contact with overhead utilities, and increased noise levels. Chemical hazards include those associated with contact with potentially impacted sediment and are identified by chemical in Section 5.

4.8 SHORELINE POLING TO ASSESS EXTENT OF RIP RAP

The extent of the rip rap will be evaluated by probing with a pole through the water column to determine where the edge of rip rap is before reaching sediment. Physical hazards associated with inter-tidal sampling include slipping and the risk of falling overboard while poling over the edge of the boat. The risk of chemical hazards are low since the sediment will not be collected, just probed.

4.9 MARINE SURVEYS

Marine surveys, both bathymetric and magnetometer, will be conducted from a small vessel. Physical hazards associated with marine surveys include slips, trips, and falls associated with work done on the boat deck, which can have a slick surface and equipment and cables on deck as potential trip hazards. There are no chemical hazards associated with marine surveys as there is no contact with potentially impacted sediment.

4.10 BOAT TRAFFIC SURVEYS

Surveys of boat traffic and tribal net fishing may be conducted weekly from a small vessel covering the Site as well as up the Lower Duwamish Waterway. Physical hazards associated with boat traffic surveys include slips, trips, and falls associated with working on a boat deck which can have a slick surface as well as potential accidents with other boats using the waterway. There are no chemical hazards associated with marine surveys as there is no contact with potentially impacted sediment.

Section 5

Hazard Evaluation – Site Contaminants

The following sections describe the potential exposure routes for workers at the Site, chemical and physical hazard assessments, and activity hazard assessments for activities to be conducted at the Site.

5.1 POTENTIAL EXPOSURE ROUTES

Field activities at the Site include the collection of potentially contaminated sediment and soil. The extent of impacted sediment at the Site is not defined; therefore, there is the potential for impacted material to be brought to the surface where workers are conducting routine sampling activities. Exposures will be managed by the proper use of PPE and safe work practices designed to minimize contact with potentially contaminated material.

Sediment samples have been collected during previous investigations at the Site. The contaminants of concern detected above the Sediment Management Standards include the following:

- PAHs and other semivolatile compounds
- PCBs
- Metals (arsenic, chromium, copper, lead, mercury, zinc)
- Tributyltin (TBT)
- Dioxins/furans

The full list of COCs is included in Attachment A.

5.2 HAZARD ASSESSMENTS

Based on previous site information and knowledge of the types of activities conducted at these locations, PAHs, metals, PCBs, and TBT may exceed screening levels. Health hazards of potential chemicals are discussed below. This information covers potential toxic effects that might occur if relatively significant acute and/or chronic exposure were to happen. This information does not mean such effects will occur from the planned site activities. In general, the chemicals that may be encountered at this Site are not expected to be present at concentrations that could produce significant exposures. The types of planned work activities and use of monitoring procedures and protective measures will limit potential exposures at this Site.

These standards are presented using the following abbreviations:

- PEL Permissible exposure limit.
- TWA Time-weighted average exposure limit for any 8-hour work shift.
- STEL Short-term exposure limit expressed as a 15-minute, time-weighted average and not to be exceeded at any time during a work day.

5.2.1 Polycyclic Aromatic Hydrocarbons

Exposure to PAHs can occur via inhalation of vapors, ingestion, and skin and eye contact. Skin contact can result in reddening or corrosion. Ingestion can cause nausea, vomiting, blood pressure fall, abdominal pain, convulsions, and coma. Damage to the central nervous system can also occur. The U.S. Department of Health and Human Services (1989) has classified 15 PAHs as having sufficient evidence for carcinogenicity, while the U.S. Environmental Protection Agency (EPA) (1990) has classified at least 5 of the identified PAHs as human carcinogens. Currently there is no assigned PEL-TWA for PAHs, but the closely related material coal tar is listed as coal tar pitch volatiles with a PEL-TWA of 0.2 milligrams per cubic meters (mg/m^3).

5.2.2 Arsenic

Arsenic is toxic by inhalation and ingestion of dusts and fumes or by inhalation of arsine gas. Trivalent arsenic compounds are the most toxic to humans, with significant corrosive effects on the skin, eyes, and mucous membranes. Dermatitis also frequently occurs, and skin sensitization and contact dermatitis may result from arsenic trioxide or pentoxide. Trivalent arsenic interacts with a number of sulfhydryl proteins and enzymes, altering their normal biological function. Ingestion of arsenic can result in fever, anorexia, cardiac abnormalities, and neurological damage. Liver injury can accompany chronic exposure. Skin and inhalation exposure to arsenic has been associated with cancer in humans, particularly among workers in the arsenical-pesticide industry or copper smelters. EPA currently classifies arsenic as a Class A, or confirmed, human carcinogen.

Arsine is a highly toxic gaseous arsenical, causing nausea, vomiting, and hemolysis. The current PEL-TWA for organic and inorganic forms of arsenic is 0.01 mg/m^3.

5.2.3 Chromium

Chromium occurs in the environment primarily in two valence states, trivalent chromium (Cr III) and hexavalent chromium (Cr VI). Exposure may occur from natural or industrial sources of chromium. Chromium III is much less toxic than chromium (VI). The respiratory tract is also the major target organ for chromium (III) toxicity, similar to chromium (VI). Chromium (III) is an essential element in humans. The body can detoxify some amount of chromium (VI) to chromium (III).

The respiratory tract is the major target organ for chromium (VI) toxicity, for acute (short-term) and chronic (long-term) inhalation exposures. Shortness of breath, coughing, and wheezing were reported from a case of acute exposure to chromium (VI), while perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, and other respiratory effects have been noted from chronic exposure. Human studies have clearly established that inhaled chromium (VI) is a human carcinogen, resulting in an increased risk of lung cancer. Although chromium-exposed workers were exposed to both chromium (III) and chromium (VI) compounds, only chromium (VI) has been found to be carcinogenic in animal studies, so EPA has concluded that only chromium (VI) should be classified as a human carcinogen. The PEL-TWA for Chromium (III) compounds is 0.5 mg/m^3.

5.2.4 Copper

Copper is a metallic element that occurs naturally as the free metal, or associated with other elements in compounds that comprise various minerals. Copper is an essential nutrient that is incorporated into a number of metalloenzymes. One of the most commonly reported adverse health effect of copper is gastrointestinal distress. Nausea, vomiting, and/or abdominal pain have been reported, usually occurring shortly after drinking a copper sulfate solution, beverages that were stored in a copper or untinned brass container, or first draw water (water that sat in the pipe overnight). The observed effects are not usually persistent and gastrointestinal effects have not been linked with other health effects. Copper is also irritating to the respiratory tract. Coughing, sneezing, runny nose, pulmonary fibrosis, and increased vascularity of the nasal mucosa have been reported in workers exposed to copper dust. The carcinogenicity of copper has not been adequately studied. The PEL-TWA for copper is 1 mg/m^3.

5.2.5 Inorganic Lead

Inorganic lead exposure can occur via inhalation of dusts or metal fumes, ingestion of dusts, and skin and eye contact. The principal target organs of lead toxicity include the nervous system, kidneys, blood, gastrointestinal, and reproductive systems. Generalized symptoms of lead exposure include decreased physical fitness, fatigue, sleep disturbances, headaches, bone and muscle pain, constipation, abdominal pain, and decreased appetite. More severe exposure can result in anemia, severe gastrointestinal disturbance, a “lead-line” on the gums, neurological symptoms, convulsions, and death.

Neurological effects are among the most severe of inorganic lead’s toxic effects and vary depending on the age of individual exposed. Effects observed in adults occur primarily in the peripheral nervous system, resulting in nerve destruction and degeneration. Wrist-drop and foot-drop are two characteristic manifestations of this toxicity.

EPA also currently lists inorganic lead as a Group B2 probable human carcinogen via the oral route. This conclusion is based on feeding studies conducted in laboratory animals. The current PEL-TWA for inorganic lead is 0.05 mg/m^3. Occupational exposure to lead is also specifically regulated under WAC 296-62-07521, with an action level established at 0.03 mg/m^3 that triggers monitoring and other requirements.

5.2.6 Mercury

Elemental (metallic) mercury primarily causes health effects when it is breathed as a vapor where it can be absorbed through the lungs. These exposures can occur when elemental mercury is spilled or products that contain elemental mercury break and expose mercury to the air, particularly in warm or poorly ventilated indoor spaces. Symptoms include tremors; emotional changes (e.g., mood swings, irritability, nervousness, excessive shyness); insomnia; neuromuscular changes (such as weakness, muscle atrophy, twitching); headaches; disturbances in sensations; changes in nerve responses; performance deficits on tests of cognitive function. At higher exposures there may be kidney effects, respiratory failure and death. The PEL-TWA for mercury is 0.25 mg/m^3.

5.2.7 Zinc

Zinc compounds can be hazardous by inhalation of dust and fumes, ingestion, and skin and eye contact. Zinc chloride is corrosive to skin and mucous membranes, and sensitization can occur resulting in dermatitis. Eye contact can produce inflammation and corneal ulceration. Ingestion can result in corrosive damage to the digestive tract. The current PEL-TWA for exposure to zinc chloride fumes is 1 mg/m^3. Zinc chromate exhibits potential carcinogenic effects and is currently limited with a PEL-TWA of 0.05 mg/m^3. Zinc oxide is toxic via inhalation of fumes and dusts and may cause dermatitis. The current PEL-TWA for zinc oxide is 10 mg/m^3 as total dust and 5 mg/m^3 as the respirable fraction.

5.2.8 Polychlorinated Biphenyls

PCB is a generic term for a range of PCB compounds used commercially in heat transfer media and in the chemical/coatings industry. PCBs have been marketed commercially under the trade names Askarel® and Aroclor®, with a designation referring to the percent weight of chlorine. Prolonged skin contact with PCBs may cause acne-like symptoms, known as chloracne. Irritation to eyes, nose, and throat may also occur. Acute and chronic exposure can cause liver damage, and symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. If pregnant women accidentally ingest PCBs, stillbirth or infant skin and eye problems may occur. PCBs are a suspect carcinogen. EPA currently classifies PCBs as a Class B2, probable human carcinogen. The PEL-TWA for PCBs with 54 percent chlorine content is 0.5 mg/m^3, while the PEL-TWA for PCBs with 42 percent chlorine is 1 mg/m^3. Skin exposure may contribute significantly to uptake of these chemicals; therefore, all skin exposure should be strictly avoided.

5.2.9 Tributyltin

TBT (organotin) is a man-made chemical used in marine antifouling paints and occurs in a solid or liquid state. In pure form (DOT guidelines), organotins are poisonous and may be fatal if inhaled, swallowed, or absorbed through skin. Contact to the pure material may cause burns to the skin and eyes. Generalized symptoms of exposure are skin and eye irritation. The toxicity of organotin compounds is the result of their lipid solubility, allowing penetration into the brain and central nervous system; however, possible contact with TBT will be diluted for sediment sampling. According to the U.S. Food and Drug Administration, the symptoms of acute tin toxicity from ingestion to humans are nausea, abdominal cramping, diarrhea, and vomiting. These symptoms have often followed consumption of canned fruit juices and salmon containing 650 to 1,400 parts per million (ppm) tin. Because of low intestinal absorption of tin (a breakdown product of organotins), the acute toxic symptoms are probably caused primarily by local irritation of the gastrointestinal tract.

The current PEL-TWA for organotin compounds, as tin, is 0.1 mg/m^3 (skin contact). The STEL is 0.2 mg/m^3.

5.2.10 Dioxins/Furans

Dioxins and furans is the abbreviated name for a family of toxic substances that all share a similar chemical structure. Most dioxins and furans are not man-made or produced intentionally, but are created when other chemicals or products, such as pesticides, are made. The chemical 2,3,7,8-tetrachloro-p-dibenzo-dioxin (2,3,7,8 TCDD) is considered the most toxic chemical within the dioxin and furan family. Exposure routes include inhalation, skin absorption, ingestion, and skin and/or eye contact. Dioxins and furans can enter one's body through breathing contaminated air, drinking contaminated water, or eating contaminated food. Dioxins and furans can build up in the fatty tissues of animals. Eating contaminated food is the primary source of exposure. Toxic symptoms in humans include eye irritation, allergic dermatitis, chloracne, porphyria, headache, weakness, gastrointestinal disturbance, and possible reproductive, teratogenic effects.

5.3 OTHER PHYSICAL HAZARDS

A variety of physical hazards may be present during site activities, both on shore and while working on the boat. The most common hazards are struck by/or against hazards during sampling operations. These may include slips, trips, and falls, and temperature extremes. Other physical hazards are due to the use of hand and power tools, and material handlings. These hazards are not unique and are generally familiar to hazardous waste workers. Additional specific safety requirements working on or near water will be covered during safety briefings at the Site.

5.3.1 Slips, Trips, and Falls

Working in and around the Site will pose slip, trip, and fall hazards due to wet terrain, slippery surfaces, or surfaces that are muddy. Potential adverse health effects include falling to the ground and becoming injured or twisting knees/ankles. These hazards will be controlled by keeping the work area free of debris and other litter. Specifically, the core processing area will be managed in such a manner that liners are not placed in high traffic areas, core material is collected in buckets or equivalent, and all workers will be aware of potential hazards associated with the walking surface. The deck of the boat will be organized in such a manner to minimize the amount of equipment and material laying on the deck that may pose a trip hazard. Site workers will wear high traction, safety-toed boots and pay careful attention to surface conditions to prevent trip and fall injuries. The work area will be inspected before the start of work each day to identify hazards that could cause injury. The results of these inspections will be communicated to site personnel during the daily tailgate and safety meetings.

5.3.2 Noise

Federal Occupational Safety and Health Administration's (OSHA's) 85-decibel A-weighted (dBA) noise exposure limit could be exceeded for those project personnel working on the boat while operating the vibracore drilling equipment, hollow-stem auger/sonic drilling, or working with power tools in the processing area. To control this exposure hazard, all personnel working near excessively noisy equipment will be required to wear hearing protection.

5.3.3 Boat Operations

Operating boats or vessels on the water carries the risk of having a crew member fall overboard and possibly drown, striking or being struck by other vessels operating in the area, losing power or steering and drifting into hazardous areas, and encountering severe weather, to name a few. The risk of a boating accident can be reduced by ensuring the boat operators are experienced, and when applicable, licensed; operating the vessel in compliance with U.S. Coast Guard (Coast Guard) rules and regulations; maintaining the vessel in good mechanical order; avoiding bad weather and dangerous seas; and ensuring emergency equipment is available on board (i.e., life vests, life rings, safety skiffs, fire extinguishers, communication equipment, etc.).

To address these concerns, all work conducted from small vessels and barges will comply with Tetra Tech's Boating Safety Procedure (EHS-9, see Attachment B), and applicable Coast Guard regulations. Vessels will be operated by experience crewmembers, and all equipment will be inspected prior to use to ensure that it is in proper working order. This inspection will be conducted by the SSHO for each vessel used on a daily basis. Ultimately, the boat operator will be responsible for the safety of all personnel on the boat and for the integrity of the vessel and its safety equipment.

Prior to the start of field activities, the boat operator will give a detailed health and safety briefing on the location and use of all vessel safety equipment and the procedures for addressing an on-board emergency (i.e., fire, mechanical failure, man overboard situation, etc.). The maximum number of passengers and weight that can safely be transported shall be posted. The number of passengers shall not exceed the number of personal floatation devices (PFDs). Boat operators and passengers will be required to wear Type III or higher Coast Guard-approved PFDs. If any work is done at night, the PFDs will be equipped with a Coast Guard-approved automatically activated light.

Vessels operated by Tetra Tech personnel will have at least one sound signaling device and a radio to communicate with support services on shore. Boating operations will be suspended during severe weather or rough seas.

5.3.4 Fire and Explosion Hazard

A gasoline powered generator and/or air compressor may be used at the Site to power the vibracore sampler and various other power tools. There is a risk of fire during refueling of the generator, particularly if fuel is spilled in the process. To prevent ignition of this fuel, the generator will be staged and operated outside, away from all ignition sources. Refueling will not be done while the generator is running. Smoking will be prohibited within 100 feet of the generator and fuel storage area. The gasoline will be stored in a safety can and will be bonded to the generator during transfer of fuel. Fuel will not be dispensed from the bed of plastic-lined pickup trucks. The generator will be grounded to a conducting rod driven into the ground, if necessary, and if such grounding is recommended by the manufacturer. A 10-pound portable dry chemical fire extinguisher and sorbent pads will be staged at the Site in the event of fuel spillage or fire.

5.3.5 Manual Lifting

Collecting coring samples, handling coring equipment, and unloading materials will involve heavy lifting. Such activities carry the risk of back and muscle strain. To control this hazard, workers will be instructed to use proper lifting techniques when moving heavy loads, particularly when unloading cores, deploying boats, stowing gear, and moving material weighing more than 50 pounds or awkwardly shaped. When engaged in such activities, workers will maintain ergonomically safe lifting postures and have others help them if mechanical lifting devices cannot be used.

5.3.6 Hand and Power Tools

Several different portable power tools, including a vibracore sampler, skill saws, and drills, may be used during the project. Power tools can cause injury if their wiring is defective, guards are missing, kill switches are broken, metal fatigue or cracks are present in reciprocating cutting and drilling appliances, or if the tools are used in a manner other than what they are designed for. To control these hazards, all power tools will be inspected before and after each use. Any defects noted during these inspections will be immediately repaired or the tool will be taken out of service. Under no circumstances will power tools be used in an inappropriate (non-specified) manner. Tool operators will be trained in the use of each type of tool they will be required to use. All electrically powered tools, as well as all electrical equipment used on site, will be connected to power sources equipped with ground fault circuit interrupters. In addition, extension cords used with the power tools will be equipped with water poof couplings to prevent electrocution wherever wet conditions may be. Portable tools will be stored in a clean, secure area after each day's use.

5.3.7 Sediment Coring Equipment

A vibracore and drill rig will be used to collect sediment samples. The vibracore consists of a long aluminum/steel tube attached to a vibrating hammer (vibracore), which is all supported by an A-frame on the back of the boat. The barge mounted drill rig will be a hollow-stem auger or sonic rig. Working with and near this equipment poses many potential hazards that can result in serious physical harm. This can include being struck by or against the equipment or pinched or caught by equipment. These hazards will be avoided by ensuring that all rotating or reciprocation parts are guarded or shielded and operators keep their hands away from any coring or cutting surfaces.

5.3.8 Temperature Extremes

Because most planned work activities will be conducted outside where temperature conditions are unpredictable, there is a risk that site workers could develop heat or cold stress. The likelihood of this occurring is dependent on environmental conditions, the level of work activity, and the personal control measures that are used to manage heat loads (work/rest regimes, use of clothing, hydration, etc.). Appropriate control measures will be taken to manage these thermal stress concerns. The SSHO will monitor ambient temperatures in the work area, track work loads, and determine the need for personal protective and administrative controls. In addition, all site workers will be instructed in the recognition and control of thermal stress symptoms and in the treatment procedures identified below.

Signs of Hypothermia

Hypothermia can result from abnormal cooling of the core body temperature. It is caused by exposure to a cold environment, and wind-chill as well as wetness or water immersion can play a significant role. The following discusses signs and symptoms as well as treatment for hypothermia.

Typical warning signs of hypothermia include fatigue, weakness, incardination, apathy, and drowsiness. A confused state is a key symptom of hypothermia. Shivering and pallor are usually absent, and the face may appear puffy and pink. Body temperatures below 90°F require immediate treatment to restore temperature to normal.

Treatment of Hypothermia

Current medical practice recommends slow rewarming as treatment for hypothermia, followed by professional medical care. This can be accomplished by moving the person into a sheltered area and wrapping with blankets in a warm room. In emergency situations where body temperature falls below 90°F and heated shelter is not available, use a sleeping bag, blankets and/or body heat from another individual to help restore normal body temperature.

Heat Stress

High heat and humidity can lead to rapid dehydration while working. Each person should have at least two liters of water with them. Heat stress and heat stroke can develop quickly. Vessels will carry a water supply and electrolyte fluids such as Gatorade® or Powerade®. Regular sips no more than 15 minutes apart in extreme high heat should prevent dehydration. Physical signs of dehydration can include one or more of the following: irritability, lethargy, reduced urination (if properly hydrated, you should urinate regularly throughout the day), headache, dizziness, lightheadedness, dry mouth, rapid heartbeat, rapid breathing, loss of skin elasticity, and dry skin. If you become severely dehydrated, do not gulp down water. Instead, take a break under shade and take small, frequent sips of water. Wearing light-colored clothing and a hat will help keep you from getting dehydrated as well. You are responsible for your personal hydration, however, team members should monitor each other and give reminders about drinking water.

5.4 ACTIVITY HAZARD ANALYSIS

The Activity Hazard Analysis (AHA) is a systematic way of identifying the potential health and safety hazards associated with major phases of work on the project and the methods to avoid, control, and mitigate those hazards. AHAs are developed for all activities as necessary, prior to start-up. The AHAs will be used to train work crews in proper safety procedures during preparatory meetings and before the beginning of each new task.

AHAs are included in Attachment C of this HASP. AHAs have been developed for the following phases of work:

- Site mobilization/demobilization,
- Sampling operations,
- Working on or near water,
- Decontamination,
- Sample processing,
- Barge-mounted drilling, and
- Upland soil sample collection with drill rig.

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Section 6
Site Access and Control

Access to the Site will be limited to those personnel engaged in the work under the Lockheed West Seattle Superfund Site project. Site control will be maintained by Tetra Tech by establishing clearly identified work zones, whenever possible.

6.1 WORK ZONES

Where there is the potential for workers to come into contact with soils and materials with chemical concentrations greater than typical background concentrations, the Site will be divided into an exclusion zone (EZ), a contamination reduction zone (CRZ), and a support zone (SZ). The EZ is defined as the area where contamination and other site hazards are either known or are likely to be present. The CRZ is where hazardous substances are removed from site personnel and their equipment as they exit the EZ. The SZ is a non-contaminated area where support services, storage of non-hazardous materials, and administrative activities may occur. There will be no smoking, eating, or drinking within the EZ or contaminant reduction zone. The zone locations will be based upon current knowledge of proposed site activities. It is possible that the zone configurations may be changed due to work plan revisions. Because most of the work with the sampling equipment will occur on the deck of the vessel and the working space will be limited, the zone boundaries will be marked as necessary. Due to the small size of some areas, there may be activities performed in the EZ that are normally performed in the CRZ. The FSL and SSHO shall monitor these activities to ensure no cross contamination, particularly for the support zone. All personnel entering the Site work zones must be Hazardous Waste Operations and Emergency Response (HAZWOPER) trained and have a current 8-hour refresher. Certificates identifying current training will be on file at the Site during periods of on-site work.

6.1.1 Exclusion Zone

The EZ will include the vibracore floating work platform and core sample examination and preparation area. These areas will be identified and isolated in such a way as to avoid interference with operations by outside personnel. Isolation protocols may include use of ropes, barricades, temporary fencing, boundary tape, warning signs, or other distinguishable markers. All personnel entering the EZ will use the buddy system to maintain vigilance over each other and will wear the personal protective equipment specified in this plan. EZ workers will also have copies of their medical clearance and training records on file at the Site.

6.1.2 Contamination Reduction Zone

A CRZ will be established between the SZ and the EZ and will be used for EZ entry and egress of personnel and emergency support services. The CRZ will contain a contamination reduction corridor that includes an area for decontamination of personnel and portable hand-held equipment, tools, and heavy equipment. All personnel and equipment must pass through the contamination reduction corridor when exiting the exclusion zone. Decontamination of personnel and equipment will be accomplished as described below. Decontamination activities to be conducted in the CRZ will require personal protection as deemed necessary by the SSHO. Due to the small areas on some vessels, the CRZ may be a simple step off/wash area or similar that is moved, as necessary, when not in use.

6.1.3 Support Zone

The SZ is located in an uncontaminated area of the site adjacent to the EZ and CRZ. Site access and the majority of site operations will be controlled from this location. The SZ will contain provisions for team communications and serve as a staging area for equipment, office facilities, drinking water, and emergency response resources. Safety equipment such as emergency eyewash, fire extinguisher, first aid kit, air horns and other equipment will be stored in the SZ and transported to work areas as necessary. No contaminated personnel or contaminated materials will be allowed in this zone except appropriately packaged and decontaminated environmental samples.

6.2 CONTAMINATION CONTROL

The following sections describe the measure that will be taken to control contamination of workers and equipment during the execution of the field activities.

6.2.1 Personnel Decontamination Station

Good personal hygiene, coupled with diligent decontamination, will significantly reduce the potential for exposure.

6.2.2 Minimization of Contact with Contaminants

During completion of all site activities, personnel should attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep “clean” during site activities. All personnel should minimize kneeling, splash generation, and other physical contact with contamination. This may ultimately minimize the degree of decontamination required and the generation of waste materials from site operations.

Field procedures will be developed to control overspray and runoff and to ensure that unprotected personnel working nearby are not affected.

6.2.3 Personnel Decontamination Sequence

Consideration will be given to prevailing wind directions so that the decontamination line, the support zone, and contamination reduction zone exit is upwind from the exclusion zone and the first station of the decontamination line. Personnel who are performing decontamination will remove all PPE used in the EZ and place the waste in drums/trash cans in the CRZ. Hand sanitizer or baby wipes shall be available for wiping hands and face.

Decontamination for site personnel wearing Level D PPE will consist of having each worker remove their hard hats, safety glasses, leather gloves, hearing protection, PFDs, and outer protective garments prior to leaving the Site and storing them in a clean area for reuse the next day.

Site personnel engaged in sediment coring and core sample preparation work while wearing Modified Level D PPE will be required to have their boots and gloves washed, rinsed, and removed before leaving the Site. They will also remove their Poly-Tyvek coveralls and place them in a plastic bag for disposal. Re-usable PVC raingear, if worn, will be rinsed clean with water, removed, and stored on site for later use.

Personnel decontamination will be conducted in a CRZ situated adjacent to and contiguous with the EZ. A large wash tub will be placed in the CRZ for workers to stand in while their outer protective clothing is washed and rinsed. Scrub brushes and soap solution may be used to remove mud and soil from clothing.

The SSHO will ensure that the above-mentioned decontamination procedures are effectively controlling the spread of contamination in the work area by periodically inspecting the recently cleaned clothing and equipment for evidence of residual contamination. The work area will also be examined to detect any sign of contamination outside of the work zones. Should it become apparent that contamination is being dispersed into clean areas of the Site, work activities will cease until more effective decontamination methods can be devised.

6.2.4 Emergency Decontamination

Emergency decontamination is discussed in the Emergency Plan, Section 10.8.

6.2.5 Hand-held Equipment Decontamination

Hand-held equipment includes all monitoring instruments, samples, hand tools, and notebooks. The hand-held equipment is dropped at the first decontamination station to be decontaminated by one of the decontamination team members. These items must be decontaminated or discarded as waste prior to removal from the EZ.

To aid in decontamination and to the extent feasible, monitoring instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants. The instruments will be wiped clean using wipes or paper towels if contamination is visually evident. Decontamination procedures for sampling equipment, hand tools, etc., shall include the use of steam cleaning or a detergent wash, as appropriate for the site conditions.

6.3 COMMUNICATIONS

The following communications equipment shall be specified as appropriate:

- Telephones – A cellular telephone will be located in the SZ for communication with emergency support services/facilities and the home office. Personnel in the EZ and CRZ are not allowed to use cellphones unless the phones can be decontaminated.
- Radio – A radio capable of receiving marine channels will be kept on the boat and in the processing area

- Hand Signals – Field teams shall use hand signals along with the buddy system. The entire field team shall know them before operations commence and their use covered during site-specific training. Typical hand signals include the following:

Signal	Meaning
Hand gripping throat	Out of air, can't breathe
Grip on a partner's wrist or placement of both hands around a partner's waist	Leave area immediately, no debate
Hands on top of head	Need assistance
Thumbs up	Okay, I'm all right, I understand
Thumbs down	No, negative

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Section 7

HAZWOPER Training and Recordkeeping

The following sections describe the training and recordkeeping requirements for the project.

7.1 HAZWOPER TRAINING

In accordance with Tetra Tech's corporate policy, and pursuant to 29 CFR 1910.120, site personnel shall have had 40-hour General Site Worker training, 3-day supervised on-the-job training, and 8-hour refresher training (if it has been at least 1 year since the initial 40-hour training of HAZWOPER). Personnel who have not met the requirements for initial training shall not be allowed to work in any site activities in which they may be exposed to hazards (chemical or physical).

7.2 SITE-SPECIFIC TRAINING

Prior to commencement of field activities, all field personnel assigned to the project will be provided training that will specifically address the activities, procedures, monitoring, and equipment for the site operations. It will include site and facility layout, hazards, and emergency services at the Site, and will highlight all provisions contained within this Plan. This training will also allow field personnel to clarify anything they do not understand and to reinforce their responsibilities regarding safety and operations for their particular activity. Boat operators will have demonstrated skills, experience, and/or appropriate training in operating the vessels (work boats and drilling platform) used on this project. The FSL will also have 8-hour Supervisor training.

7.3 ON-SITE SAFETY BRIEFINGS

Project personnel and visitors will be given daily on-site health and safety briefings by the FSL/SSHO to assist site personnel in safely conducting their work activities. The briefings will include information on new operations to be conducted, changes in work practices, or the Site's environmental conditions. The briefings will also provide a forum to facilitate conformance with safety requirements and to identify performance deficiencies related to safety during daily activities or as a result of safety audits.

7.4 FIRST AID AND CPR

The SSHO and at least one other site worker shall have First Aid and CPR training in order to ensure that emergency medical treatment is available during field activities. A list of first aid qualified personnel will be posted at the Site. The training will be consistent with the requirements of the American Red Cross Association.

7.5 HAZARD COMMUNICATION

In order to ensure chemical safety on Site, information about the identities and hazards of the chemicals used or potentially encountered must be available and understandable to project personnel and visitors. Material Safety Data Sheets (MSDS) will be readily available for all chemicals brought on site as well as lists of all chemicals monitored. All secondary containers will be clearly labeled as to their contents.

7.6 GENERAL SITE RULES

Attachment D presents Tetra Tech's general site rules that will apply to all Tetra Tech employees and subcontractors associated with this project.

Section 8
Medical Surveillance

All contractor and subcontractor personnel performing field work where potential exposure to contaminants exists at the Site are required to have passed a complete medical surveillance examination in accordance with 29 CFR 1910.120(f).

The Medical Surveillance Program is described in detail in Tetra Tech's Corporate Health and Safety Program DCN 03-02. The Corporate Medical Consultant is Work Care based in California.

8.1 MEDICAL SURVEILLANCE REQUIREMENTS

A physician's medical release for work will be confirmed by the SSHO before an employee can work in the EZ. The examination will be taken annually or biennially (with physician approval) and upon termination of hazardous waste site work if the last examination was not taken within the previous 6 months. Additional medical testing may be required by the PESM in consultation with the Corporate Medical Consultant and the SSHO if an over-exposure or accident occurs, if an employee exhibits symptoms of exposure, or if other site conditions warrant further medical surveillance.

8.2 MEDICAL DATA SHEET

A medical data sheet is provided in Attachment E. This medical data sheet is voluntary and should be completed by all on-site personnel and will be maintained at the Site. Where possible, this medical data sheet will accompany the personnel needing medical assistance. The medical data sheet will be maintained in a secure location, treated as confidential, and used only on a need-to-know basis.

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Section 9
Personal Protective Equipment

The PPE specified in Table 9-1 represents the hazard analysis and PPE selection required by 29 CFR 1910.132. Specific information on the selection rationale for each activity can be found under Section 4.0 and Attachment C for AHAs. For the purposes of PPE selection, the PESM and SSHO are considered competent persons.

Modifications for initial PPE selection may also be made by the SSHO in consultation with the PESM. A written justification for downgrades will be provided to the PESM for approval as a field change request.

PPE ABBREVIATIONS

HEAD PROTECTION

HH = hard hat

HEARING PROTECTION

EP = ear plugs

EYE/FACE PROTECTION

GOG = goggles
PFS = plastic face shield
SG = ANSI approved safety glasses with side shields

FOOT PROTECTION

OB = overboot
Rub = rubber slush boots
STB = leather work boots with steel toe

HAND PROTECTION

LWG = leather work gloves
Nit = nitrile
Sur = surgical

BODY PROTECTION

WC = work clothes
Cot Cov = Cotton Coveralls
Poly = polyethylene coated Tyvek® coveralls
Saran = saranex coated Tyvek® coveralls

RESPIRATORY PROTECTION

Level D = No respiratory protection required
Level C = Full face air purifying respirator with N-99 cartridges
Level B = Full face air supplied respirator with escape bottle

Because volatile organic compounds are not on the list of contaminants of concern, and given that the material will be saturated and not prone to volatize, air monitoring will not be conducted during the field program. Table 9-1 summarizes the PPE required for each task.

Table 9-1
Personal Protective Equipment Selection

Task	Head	Eye	Feet	Hands	Body	Hearing	Respirator
Mobilization/ Demobilization	HH, if overhead hazard	SG	STB	LWG	WC	EP as determined necessary by the SSHO	Level D
Shoreline Poling of Rip Rap	HH, if overhead hazard	SG	STB + OB or Rub	LWG	WC and/or Poly/Saran as determined by SSHO	EP as determined necessary by the SSHO	Level D initially, Modified Level D as indicated by SSHO and when needed to prevent dermal contact with sediments.
Sediment Core Sampling (vibracore and drill rig)	HH, if overhead hazard	SG	STB + OB or Rub	Nit	WC and/or Poly/Saran as determined by SSHO	EP as determined necessary by the SSHO	Level D initially, Modified Level D as indicated by SSHO and when needed to prevent dermal contact with sediments.
Core Sample Processing	HH, if overhead hazard	SG	STB + OB or Rub	Nit	WC and/or Poly/Saran as determined by SSHO	EP as determined necessary by the SSHO	Level D initially, Modified Level D as indicated by SSHO and when needed to prevent dermal contact with sediments.
Equipment Decontamination	N/A	GOG + PFS	STB + OB or Rub	Nit	WC and/or Poly/Saran as determined by SSHO	EP as determined necessary by the SSHO	Level D initially, Modified Level D as indicated by SSHO and when needed to prevent dermal contact with sediments.

HH = hard hat
GOG = goggles
PFS = plastic face shield
STB = leather work boots with steel toe
OB = overboot
Nit = nitrile
LWG = leather work gloves
WC = work clothes
SSHO = Site Safety and Health Officer
Rub = rubber slush boots
EP = ear plugs
Poly = polyethylene coated Tyvek® coveralls
Saran = saranex coated Tyvek® coveralls

9.1 OSHA REQUIREMENTS FOR PERSONAL PROTECTIVE EQUIPMENT

All PPE used during the course of this field activity must meet the following OSHA standards:

Type of Protection	Regulation	Source
Eye and Face	29 CFR 1910.133	ANSI Z87.1
Respiratory	29 CFR 1910.134	ANSI Z88.1
Head	29 CFR 1910.135	ANSI Z89.1
Foot	29 CFR 1910.136	ANSI Z41.1
Hand	29 CFR 1910.138	
Hearing	29 CFR 1910.95	
Protective Clothing	29 CFR 1910.132	

ANSI = American National Standards Institute

Under worst-case dry conditions and contaminate concentrations at the maximum level identified, it is possible for airborne levels to exceed lowest allowed exposure levels (see Table 9-2). In that sampling will be performed wet, and samples will be promptly sealed, exposures significantly less than the levels identified below will be encountered.

To help ensure this, the SSHO shall monitor work conditions. If samples are not kept wet, and visible dust emissions occur, the SSHO can require the use of personal dust monitoring or compound-specific air monitoring. If dust monitoring is used, an action level of 2 mg/m^3 shall be used to ensure an appropriate safety factor.

Table 9-2
COC Concentrations

Contaminant	Maximum Sediment Concentration (mg/kg)	Percent of Contaminant in Sediment	Lowest Air Action Level (OSHA PEL, mg/m^3)	Maximum Air Concentration for 10 mg/m^3 Dust Concentration (mg/m^3)	Maximum Air Concentration > Lowest Air Action Level (yes/no)
Arsenic	374	0.03	0.01	0.003	no
Chromium	925	0.09	0.5	0.009	no
Copper	2620	0.26	1	0.026	no
Lead	2200	0.22	0.05	0.022	no
Mercury	17.1	0.0017	0.25	0.0002	no
Zinc (assumed Zinc Oxide)	2680	0.27	5	0.027	no
PCBs	9.6	0.0009	0.5	0.00009	no
TBT	9.1	0.0009	0.1	0.00009	no

Due to the nature of the tasks involved and the size of the Site, the SSHO will choose PPE on a daily basis depending on the operation, location, and the hazards involved in each task. The level of PPE protection will be upgraded or downgraded based on changes in site conditions.

Several factors that may indicate the need to re-evaluate site conditions and PPE selection include the following:

- Encountering or handling contaminants other than those previously identified,
- Commencement of a new work phase,
- Change in job tasks during a work phase,
- Change of season/weather,
- Change in work scope that affects the degrees of contact with contaminants, and
- Change of ambient levels of contaminants.

All major PPE changes that deviate from this plan must be approved in advance by the PESM.

The various levels of PPE referenced in this plan (Level D, Modified Level D, and Level C) are described below.

Level D

If the potential for direct chemical contact is minimal (such as mobilizing equipment and surveying site), or if workers are going to be outside the exclusion and contamination reduction zones, then Level D PPE will be prescribed as follows:

- Cotton coveralls, leather gloves, hard hat, and safety glasses with side shields;
- Chemical-resistant boots or leather work boots with steel toe;
- High-intensity road vests when working near heavy equipment;
- Optional disposable boot covers and chemical-protective gloves;
- Hearing protection as required; and
- PFDs while on the water or within 6 feet of water if on the shoreline.

Modified Level D

Modified Level D will be worn by those site workers who may come into direct skin contact with the contaminated sediments (such as when collecting core samples and examining and preparing core samples for laboratory analysis and shipment) without significant inhalation exposure.

Modified Level D will consist of the following items:

- Disposable Poly-Tyvek coveralls or equivalent, or lightweight reusable raingear;
- Nitrile gloves and PVC steel-toe boots with optional latex booties;
- Hard hats;
- Safety glasses with side shields;
- High-intensity road vests when working around heavy equipment;
- Hearing protection as required; and
- PFDs while on the water or within 6 feet of water if on the shoreline.

Level C

Level C PPE, which includes the use of respiratory protection, is not authorized under this plan.

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Section 10

Emergency Response Plan

This section establishes procedures and provides information for use during a project emergency. Emergencies happen unexpectedly and quickly and require an immediate response; therefore, contingency planning and advanced training of staff is essential. Specific elements of emergency support procedures that are addressed in the following subsections include communications, local emergency support units, preparation for medical emergencies, first aid for injuries incurred on site, record keeping, and emergency site evacuation procedures.

10.1 RESPONSIBILITIES

The following sections describe the responsibilities of the PESM, Emergency Coordinator, and Site Personnel, as well as emergency response activities.

10.1.1 Project Health and Safety Manager

The PESM oversees and approves the Emergency Response/Contingency Plan and performs audits to determine that the plan is in effect and that all pre-emergency requirements are met. The PESM acts as a liaison to applicable regulatory agencies and notifies OSHA of reportable accidents.

10.1.2 Emergency Coordinator

The Emergency Coordinator is the FSL. In the event of an emergency, the Emergency Coordinator shall make contact with local emergency response personnel. In these contacts, the Emergency Coordinator will inform response personnel about the nature of work on the Site, the type of contaminants and associated health or safety effects, and the nature of the emergency, particularly if it is related to exposure to contaminants.

The Emergency Coordinator shall review this plan, verify the emergency phone numbers on Table 10-1, and review the hospital route prior to beginning work on-site. The Emergency Coordinator shall make necessary arrangements to be prepared for any emergencies that could occur.

The Emergency Coordinator shall implement the Emergency Response/Contingency Plan whenever conditions at the Site warrant such action.

10.1.3 Site Personnel

Site personnel are responsible for knowing the Emergency Response/Contingency Plan and the procedures contained herein. Personnel are expected to notify the Emergency Coordinator of situations that could constitute a site emergency.

10.2 COMMUNICATIONS

A variety of communication systems may be utilized during emergency situations. These are discussed in the following sections.

During an emergency, the primary form of communication between field groups in the EZ and the Emergency Coordinator will be verbal communications. During an emergency situation, the lines will be kept clear so that all field teams can receive instructions. A cellular telephone will be available outside of the EZ contaminant reduction zone on-site.

Air horns will be used to alert site personnel of emergencies. The following signals will be used:

- Two short blasts = shut down equipment, await instructions
- Three short blasts = injured employee, first-aid providers respond
- One continuous blast = site evacuation

The procedure to activate the air horns consists of depressing the air horn button or switch while pointing it in the direction of the area to be signaled. Air horns should be tested at least monthly to ensure that they are working properly.

Field teams will employ hand signals when necessary for communication during emergency situations. Hand signals are found in Section 6.3.

10.3 PRE-EMERGENCY PLANNING

Emergency telephone numbers should be readily available in the immediate work area and in the SZ in order to deal with any emergency that might occur during remedial activities at the Site. These telephone numbers are presented in Table 10-1. Hospital route maps are provided in Attachment F. The emergency phone numbers listed are preliminary. Upon mobilization, the

SSHO shall verify all numbers and document any changes in the site logbook. Any changes shall also be documented with a field change request form. It is not possible to determine the emergency evacuation routes until the Site is set up. Prior to the commencement of field activities, the evacuation routes for potential emergencies in the processing area and from the vessel will be clearly identified, posted, and communicated to all site personnel.

Table 10-1
Emergency Telephone Numbers

Emergency Service	Telephone Number
Police	911
Fire	911
Ambulance	911
Virginia Mason Hospital Emergency Room	206-583-6433
Harborview Medical Center	206-744-3000
EPA National Response Center	800-424-8802
Poison Control Center	800-222-1222
Jennifer Kraus, FSL, SSHO	303-218-0585
Gary Braun, Project Manager	425-482-7840
Tami Froelich, PESM	509-372-5827
U.S. Coast Guard, Sector Puget Sound	206-217-6001 or VHF chnl 16

Each person who will be working on the Site or observing the operations will be asked to complete a medical data sheet before fieldwork commences. These data sheets will be filled out during the initial site safety-training meeting and will be kept on the Site. In the event of an incident where a team member has to be taken to a hospital, a copy of his/her medical data sheet will be presented to the attending physician.

10.4 EMERGENCY MEDICAL TREATMENT

The procedures and rules in this Plan are designed to prevent employee injury. However, should an injury occur, no matter how slight, it will be reported to the FSL/SSHO immediately. First-aid equipment will be available on site.

During the site safety briefing, project personnel will be informed of the location of the first aid station(s) that has been set up. Unless they are in immediate danger, severely injured persons will not be moved until paramedics can attend to them. Some injuries, such as severe cuts and lacerations or burns, may require immediate treatment. Any first aid instructions that can be obtained from doctors or paramedics before an emergency-response squad arrives at the Site or before the injured person can be transported to the hospital will be followed closely.

If personnel are transported to the hospital, the FSL/SSHO will provide a copy of the Medical Data Sheet to the paramedics and treating physician. Only in **non-emergency** situations will an injured person be transported to the hospital by means other than an ambulance.

10.5 EMERGENCY SITE EVACUATION ROUTES AND PROCEDURES

All project personnel will be instructed on proper emergency response procedures and locations of emergency telephone numbers during the initial site safety meeting. If an emergency occurs at the work area, including but not limited to fire, explosion, or significant release of toxic gas into the atmosphere, immediate evacuation of all personnel is necessary due to an immediate or impending danger. All heavy equipment will be shut down and all personnel will evacuate the work areas and assemble at a pre-determined location.

As field activities at this location are anticipated to be limited to several weeks, evacuation drills may be performed.

10.6 FIRE PREVENTION AND PROTECTION

In the event of a fire or explosion, procedures will include immediately evacuating the work area and the Emergency Coordinator will immediately notify the local fire and police departments. No personnel will fight a fire beyond the stage where it can be put out with a portable extinguisher (incipient stage).

Adhering to the following precautions will help to prevent fires:

- Good housekeeping and storage of materials,
- Storage of flammable liquids and gases away from oxidizers,
- No smoking in the EZ or any work area,
- No hot work without a properly executed hot work permit,
- Shutting off engines to refuel,
- Grounding and bonding metal containers during transfer of flammable liquids,
- Use of Underwriters Laboratory–approved flammable storage cans,

- Fire extinguishers rated at least 10 pounds ABC located on all heavy equipment, in all trailers, and near all hot work activities, and
- Monthly inspections of all fire extinguishers.

10.7 OVERT CHEMICAL EXPOSURE

The following are standard procedures to treat chemical exposures. Other specific procedures detailed on the MSDS or recommended by the Corporate Medical Consultant will be followed, when necessary. If first aid or emergency medical treatment is necessary, the Emergency Coordinator will contact the emergency facilities.

Skin and Eye Contact:	Use copious amounts of soap and water. Wash/rinse affected areas thoroughly, then provide appropriate medical attention. Eyes should be rinsed for 15 minutes upon chemical contamination. Skin should also be rinsed for 15 minutes if contact with caustic or acid chemical should occur.
Inhalation:	Move to fresh air. Decontaminate and transport to hospital or local medical provider.
Ingestion:	Decontaminate and transport to emergency medical facility.
Puncture Wound or Laceration:	Decontaminate and transport to emergency medical facility.

10.8 DECONTAMINATION DURING MEDICAL EMERGENCIES

If emergency life-saving first aid and/or medical treatment are required, normal decontamination procedures may need to be abbreviated or postponed. The SSHO or designee will accompany contaminated victims to the medical facility to advise on matters involving decontamination, when necessary. The outer garments can be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Respiratory equipment, if used, must always be removed. Protective clothing can be cut away. If the outer contaminated garments cannot be safely removed on site, a plastic barrier between the injured individual and clean surfaces should be used to help prevent contamination of the inside of ambulances and/or medical personnel. Outer garments may then be removed at the medical facility. No attempt will be made to wash or rinse the victim if his/her injuries are life threatening, unless it is known that the individual has been contaminated with an extremely toxic or corrosive material, which could also cause severe injury or loss of life to emergency response personnel. For minor medical problems or injuries, the normal decontamination procedures will be followed.

10.9 ACCIDENT/INCIDENT REPORTING

As soon as first aid and/or emergency response needs have been met, the following parties are to be contacted by telephone:

- PESM, Tami Froelich, 509-372-5827
- Design Project Manager, Gary Braun, 425-482-7840
- The employer of any injured worker who is not a Tetra Tech employee.

Written confirmation of verbal reports are to be submitted within 24 hours. The accident/incident report is provided in Attachment E, Field Forms. If the employee involved is not a Tetra Tech employee, his/her employer shall receive a copy of the report.

10.10 ADVERSE WEATHER CONDITIONS

In the event of adverse weather conditions, the SSHO in conjunction with the FSL, will determine if work can continue without potentially risking the safety of all field workers.

Some of the items to be considered prior to determining if work should continue include the following:

- Potential for cold, stress, and cold-related injuries;
- Treacherous weather-related working conditions (hail, rain, snow, ice, and/or high winds);
- Limited visibility (fog);
- Potential for floods or high current conditions;
- Potential for electrical storms; and
- Small craft boat advisories.

Site activities will be limited to daylight hours, or when suitable artificial light is provided, and acceptable weather conditions prevail. The SSHO will determine the need to cease field operations or observe daily weather reports and evacuate, if necessary, in case of severe inclement weather conditions.

10.11 SPILL CONTROL AND RESPONSE

All small hazardous spills/environmental releases shall be contained as close to the source as possible. Whenever possible, the MSDS will be consulted to assist in determining the best means of containment and cleanup. For small spills, sorbent materials such as sand, sawdust, or commercial sorbents should be placed directly on the substance to contain the spill and aid recovery. Any acid spills should be diluted or neutralized carefully prior to attempting recovery. Berms of earthen or sorbent materials can be used to contain the leading edge of the spills. Drains or drainage areas should be blocked. All spill containment materials will be properly disposed as hazardous waste. An EZ of 50 to 100 feet around the spill area should be established depending on the size of the spill. The FSL/SSHO should take the following steps:

1. Determine the nature, identity, and amounts of major spill components.
2. Make sure all unnecessary persons are removed from the spill area.
3. Notify appropriate response teams and authorities.
4. Use proper PPE in consultation with the SSHO.
5. If a flammable liquid, gas, or vapor is involved, remove all ignition sources and use non-sparking and/or explosive proof equipment to contain or clean up the spill (diesel only vehicles, air operated pumps, etc.).
6. If possible, try to stop the leak with appropriate material.
7. Remove all surrounding materials that can react or compound with the spill.
8. Notify the DPM, Gary Braun, at 425-482-7840.

10.12 EMERGENCY EQUIPMENT

The following minimum emergency equipment shall be kept and maintained on site.

- Industrial first aid kit (including a CPR kit),
- Bloodborne pathogen kit,
- Portable eye washes (15 minute),
- Fire extinguishers (one per vehicle and heavy equipment), and
- Absorbent material.

10.13 POSTINGS

The following information shall be posted or readily visible and available at conspicuous locations throughout the Site.

- Emergency telephone numbers, and
- Hospital Route Maps (see Attachment F).

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Section 11

Logs, Reports, and Recordkeeping

The following sections provide a summary of required health and safety logs, reports, and recordkeeping for the Project.

11.1 ON-SITE LOG

A log of personnel on Site each day will be kept by the SSHO. Originals will be kept in the project file.

11.2 HEALTH AND SAFETY REPORTS

The SSHO shall complete Daily Safety Briefings. The form is provided in Attachment E.

11.3 ACCIDENT/INCIDENT REPORTS

A Tetra Tech accident/incident report must be completed following procedures given in Section 10.9 of this HASP. The originals will be sent to the Regional Records Coordinator for maintenance by Tetra Tech. Copies will be distributed as stated. A copy of the forms will be kept in the project file.

11.4 MATERIAL SAFETY DATA SHEETS

MSDSs will be obtained and kept on file at the Site for each hazardous chemical brought to, used, or stored at the Site. The MSDS will be kept in the project file.

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Section 12
Field Team Review

This form serves as documentation that field personnel have read, or have been informed of, and understand the provisions of the HASP for site activities conducted on the Lockheed West Seattle Superfund Site, Seattle, Washington. It is maintained on-site by the FSL/SSHO as a project record.

Each field team member shall sign this section after site-specific training is completed and before being permitted to work on site.

I have read, or have been informed of, the HASP and understand the information presented. I will comply with the provisions contained therein.

Name (Print and Sign)	Date

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Section 13
Agency Review

This form serves as documentation that Agency personnel and their contractors who will be on-site have read, or have been informed of, and understand the provisions of the HASP for Site activities conducted on the Lockheed West Seattle Superfund Site, Seattle, Washington. It is maintained on-site by the FSL/SSHO as a project record.

Each Agency or contractor representative shall sign this section after site-specific training is completed and before being permitted to observe the work on the Site.

I have read, or have been informed of, the HASP and understand the information presented. I will comply with the provisions contained therein.

Name (Print and Sign)	Date

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ATTACHMENT A

Contaminants of Concern

Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)
Total PCBs	Yes	µg/kg dw	Subtidal	2 (nat. bkgd)	n/a	n/a	100 (RBTC – fish)
			Intertidal	2 (nat. bkgd)	n/a	n/a	n/a
			Point	n/a	n/a	12 mg/kg-OC/ 180 (SQS)	n/a
cPAHs	Yes	µg TEQ/kg dw	Subtidal	9 (nat. bkgd)	550 (RBTC)[6]	n/a	n/a
			Intertidal	9 (nat. bkgd)	15 (RBTC)[7]	n/a	n/a
			Point	n/a	n/a	n/a	n/a
Arsenic	Yes	mg/kg dw	Subtidal	7 (nat. bkgd)	7 (nat. bkgd)	n/a	n/a
			Intertidal	7 (nat. bkgd)	7 (nat. bkgd)	n/a	n/a
			Point	n/a	n/a	57 (SQS)	n/a
Lead	Yes	mg/kg dw	Subtidal	11 (nat. bkgd)	n/a	n/a	n/a
			Intertidal	11 (nat. bkgd)	n/a	n/a	50 (RBTC – sandpiper)
			Point	n/a	n/a	n/a	n/a
Tributyltin	Yes	µg/kg dw	Subtidal	430 (RBTC – child)	n/a	n/a	150
			Intertidal	2,000 (RBTC – child)[8]	n/a	n/a	n/a
			Point	n/a	n/a	n/a	n/a
Copper	Yes	mg/kg dw	Subtidal	400 (RBTC – child)	n/a	n/a	114 (RBTC – fish)
			Intertidal	400 (RBTC – child)[8]	n/a	n/a	420 (RBTC – sandpiper)
			Point	n/a	n/a	390 (SQS/CSL)	n/a
Mercury	Yes	mg/kg dw	Subtidal	0.41 (RBTC – child)	n/a	n/a	n/a
			Intertidal	0.17 (RBTC – child)	n/a	n/a	n/a
			Point	n/a	n/a	0.41 (SQS)	n/a
Dioxins/ Furans	Yes	ng TEQ/kg dw	Subtidal	2 (nat. bkgd)	37 (RBTC)[8]	n/a	n/a
			Intertidal	2 (nat. bkgd)	13 (RBTC)[8]	n/a	n/a
			Point	n/a	n/a	n/a	n/a

Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)
Antimony	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	150 (LAET/SL)	n/a
Cadmium	No	mg/kg dw	Subtidal	0.398 (nat. bkgd)	n/a	n/a	n/a
			Intertidal	0.398 (nat. bkgd)	n/a	n/a	n/a
			Point	n/a	n/a	n/a	n/a
Chromium	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	260 (SQS)	n/a
Cobalt	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	10 (LAET/SL)	n/a
Nickel	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	140 (LAET/SL)	n/a
Selenium	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	1 (LAET/SL)	n/a
Vanadium	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	57 (LAET/SL)	n/a
Zinc	No	mg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	410 (SQS)	n/a
Pentachloro-phenol	No	µg/kg dw	Subtidal			n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	360 (SQS)	n/a
Bis(2-ethylhexyl)-phthalate	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	47 mg/kg-OC/ 710 (SQS)	n/a
Acenaphthene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a

Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	16 mg/kg-OC/ 240 (SQS)	n/a
Benzo(a)-anthracene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	110 mg/kg-OC/ 1,700 (SQS)	n/a
Benzo(a)-pyrene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	99 mg/kg-OC/ 1,500 (SQS)	n/a
Benzo(g,h,i)-perylene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	31 mg/kg-OC/ 470 (SQS)	n/a
Total Benzofluor-anthenes	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	230 mg/kg-OC/ 1,800 (SQS)	n/a
Chrysene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	110 mg/kg-OC/ 1,700 (SQS)	n/a
Dibenz(a,h)-anthracene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	12 mg/kg-OC/ 180 (SQS)	n/a
Fluoranthene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	160 mg/kg-OC/ 2,400 (SQS)	n/a

Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)
Indeno(1,2,3-cd)pyrene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	34 mg/kg-OC/ 510 (SQS)	n/a
Phenanthrene	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	100 mg/kg-OC/ 1,500 (SQS)	n/a
Total HPAH	No	µg/kg dw	Subtidal	n/a	n/a	n/a	n/a
			Intertidal	n/a	n/a	n/a	n/a
			Point	n/a	n/a	960 mg/kg-OC/ 14,400 (SQS)	n/a

Summary of Cleanup Levels for Contaminants of Concern in Sediment

COC	Risk Driver?	Units[1]	Spatial Scale of Exposure[2]	RAO 1 Human Seafood Consumption[3] (0 to 10 cm)	RAO 2 Human Direct Contact[3] (0 to 45 cm)	RAO 3 Benthic Organisms[4] (0 to 10 cm)	RAO 4 Ecological[5] (0 to 10 cm)

[1] Unless noted differently in RAO-specific values

[2] The spatial scale of exposure is measured as site-wide (i.e., all subtidal and intertidal sediments), intertidal sediments only, and point measurements at single locations throughout the site (i.e., all subtidal and intertidal sediment locations) or at single locations in intertidal sediment only. The spatial scale is RAO-specific, with site-wide exposures applicable to human seafood consumption, human direct contact, and exposures of fish and crab. Intertidal-only exposures are applicable to human consumption of clams from intertidal areas and exposures of sandpiper. Point exposures are applicable to benthic organisms, which are evaluated at single station locations. The statistical metric for site-wide and intertidal evaluation of alternatives and compliance monitoring is the upper confidence limit on the mean, whereas point exposures are evaluated with concentration data at single locations.

[3] Cleanup levels are based on 10^{-6} cancer risk for carcinogens (e.g., PCBs, cPAHs, arsenic) or on a child exposure hazard quotient of 1 for noncarcinogens (lead, tributylin, copper). Where Cleanup Levels are based on carcinogenic risks below background, the background concentration is selected; where no background values are available (chlordanes and DDT), the method detection limit (MDL) is selected.

[4] Applicable on a point exposure only. Values for PCBs and PAHs (except total benzofluoranthenes) are the organic carbon-normalized SQS and the dry weight equivalent based on an average sediment TOC content of 1.5%; for all other compounds values are dry weight. Under the SMS, sediment cleanup standards are established on a site-specific basis within an allowable range. The SQS and CSL define this range. For chemicals without SMS, LAET and 2LAET values or the SL and ML of the DMMP define this range.

[5] Cleanup levels for site-wide exposure are the lowest for either fish or crab; Cleanup levels for intertidal exposure are for sandpiper.

[6] The cleanup level for site-wide direct contact is based on netfishing.

[7] The cleanup level for intertidal direct contact is based on the lowest for either Tribal clamming or child beach play exposures.

[8] The cleanup for intertidal seafood consumption is based on consumption of clams from the intertidal sediment.

Notes:
µg/kg dw = micrograms per kilogram dry weight
µg TEQ/kg dw = micrograms Toxicity Equivalents per kilogram dry weight
COC = contaminant of concern
cm = centimeter(s)
cPAH = carcinogenic polycyclic aromatic hydrocarbon
CSL = cleanup screening level
DMMP = dredge material management program
dw = dry weight
HPAH = heavy weight polycyclic aromatic hydrocarbon
LAET = lowest apparent affect threshold
ML – maximum level
mg/kg-dw = milligrams per kilogram dry weight
n/a = compounds do not present a risk for the RAO scenario
Nat Bkgd = natural background
ng TEQ/kg-dw = nanograms toxicity equivalents per kilogram dry weight
OC = organic carbon (1.5%)
PCB = polychlorinated biphenyl
RAO = remedial action objective
RBTC = risk-based threshold concentrations
SL = screening level
SMS = Sediment Management Standards
SQS = sediment quality standards

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ATTACHMENT B

Boating Operations

BOATING

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NOTICE OF OWNERSHIP AND CONDITIONS OF USE

ATTACHMENT C

Activity Hazard Analyses

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle	Location: Seattle, Washington
Activity: SITE MOBILIZATION/DEMOBILIZATION	Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
1. Mobilization/demobilization of equipment and supplies	1. Back Injuries	1. Site personnel will be instructed on proper lifting techniques; mechanical devices should be used to reduce manual handling of materials; team lifting should be utilized if mechanical devices are not available.
2. Establish Site security, work zones and staging areas	2. Slips/Trips/Falls	1. Maintain work areas safe and orderly; unloading areas should be on even terrain; mark and repair if possible tripping hazards.
	3. Overhead Hazards	1. Personnel will be required to wear hard hats that meet ANSI Standard Z89.1.
	4. Dropped Objects	1. Steel toe boots meeting ANSI Standard Z41 will be worn during all site activities.
	5. Noise	1. Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs); SSHO will determine the need for hearing protection; all equipment will be equipped with manufacturer's required mufflers.
	6. Heavy Equipment Movement	1. Only trained personnel will operate equipment. A spotter will be used at all times during movement. The operator shall perform the operational safety check prior to the commencement of activities.
	7. Pinch/Cut/Slash	1. Use hand tools properly and wear appropriate protective equipment, cut resistant work gloves will be worn when dealing with sharp objects.
	8. Contact with Utilities	1. Utility Locate will be used to identify all upland utilities in the sampling area and routes of any utilities leading under the sediment surface. 2. All overhead utilities will be identified prior to equipment operations; no equipment or personnel closer than 10 feet to energized electrical lines or unprotected/ unshielded circuits or similar structures.
	9. Temperature Extremes	1. Drink plenty of fluids; train personnel of signs/symptoms of heat/cold stress; monitor air temperatures when extreme weather conditions are present; and stay in visual and verbal contact with your buddy.
	10. Use of Hand and Power Tools	1. Daily inspections will be performed; all hand and power tools will be maintained in safe condition; remove broken or damaged tools from service; guards will be kept in place while using hand and power tools; use the tool for its intended purpose and in accordance with manufacturer's instructions.
	11. Working Outside in Inclement Weather	1. Monitor weather conditions daily; seek shelter when thunder and lightning is present and do not return outdoors until lightning and thunder has stopped for 30 minutes.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: SAMPLING OPERATIONS — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
1. Collect subsurface sediment samples using Vibracore, van Veen sampler, or CPT	1. Slips/Trips/Falls	1. Maintain work areas safe and orderly; unloading areas should be on even terrain; mark and repair if possible tripping hazards.
	2. Chemical Hazards	1. Appropriate protective clothing will be worn during drilling and sampling operations; skin will be rinsed with water if contact with hazardous material occurs; a portable eye wash station will be located by work area; conduct hazard communication training for decontamination and sample preservation chemicals. Follow good personal hygiene practices.
	3. Overhead Hazards	1. All overhead utilities will be identified prior to equipment operations; no equipment or personnel closer than 10 feet to energized electrical lines or unprotected/ unshielded circuits or similar structures.
	4. Dropped Objects	1. Steel toe boots meeting ANSI Standard Z41 will be worn during all site activities.
	5. Noise	1. Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs); SSHO will determine the need for hearing protection; all equipment will have manufacturer's required mufflers.
	6. Heavy Equipment Operation	1. Only trained personnel will operate equipment. A spotter will be used at all times during movement. Operator shall perform operational safety prior to the commencement of activities.
	7. Pinch/Cut/Slash	1. Use hand tools properly and wear appropriate protective equipment, cut resistant work gloves will be worn when dealing with sharp objects; all hand and power tools will be maintained in safe condition; guards will be kept in place while using hand and power tools.
	8. Fire/ Explosion	1. ABC type fire extinguishers shall be readily available. No smoking in work area. Bond and ground portable generator and gasoline can when refilling generator with fuel.
	9. Temperature Extremes	1. Drink plenty of fluids; train personnel of signs/symptoms of heat/cold stress; monitor air temperatures when extreme weather conditions are present; stay in visual and verbal contact with your buddy; and use Temperature Extremes program EHS 4-6.
	10. Hand and Power Tools	1. Daily inspections will be performed; remove broken or damaged tools from service. Use the tool for its intended purpose; and use in accordance with manufacturer's instructions. Ensure water-proof extension cords are used to power equipment.
	11. Inclement Weather	1. Monitor weather conditions daily.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: WORKING ON OR NEAR WATER — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
1. Sampling Operations over water (for hazards related to Vibracore operations, see Vibracore AHA)	1. Chemical hazards.	1. Wear the appropriate PPE. Practice contamination avoidance. Follow proper decontamination procedures. Ensure sample containers are properly decontaminated before handling them. Wash hands/face before eating, drinking or smoking.
2. Sampling over water and on shoreline	1. Slips/Trips/Fall 2. Falling overboard while collecting cores with hand sampler or poling rip-rap	1. Maintain work areas safe and orderly; unloading areas should be on even terrain; mark and repair tripping hazards, if possible. 2. Use fall protection while leaning over edge of boat with pole or hand corer.
3. Sample handling	1. Drowning	1. A buddy/ rescue person shall be on shore during all activities when personnel are in the water. A throwable flotation device shall be available. Wear PFD when working on or near water deeper than 1 foot.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: DECONTAMINATION — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
1. Decontaminate personnel	1. Chemical Hazards.	1. Wear the appropriate PPE. Practice contamination avoidance. Follow proper decontamination procedures. Ensure sample containers are properly decontaminated before handling them. Wash hands/face before eating, drinking, or smoking.
2. Decontaminate equipment	1. Slips/Trips/Falls	1. Maintain work areas safe and orderly; unloading areas should be on even terrain; mark and repair if possible tripping hazards.
	2. Overhead Hazards	1. Personnel will be required to wear hard hats that meet ANSI Standard Z89.1.
	3. Dropped Objects	1. Steel toe boots meeting ANSI Standard Z41 will be work during all Site activities.
	4. Noise	1. Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs); SSHO will determine the need for hearing protection; all equipment will be equipped with manufacturer's required mufflers.
	5. Back Injuries due to manual lifting	1. Site personnel will be instructed on proper lifting techniques; mechanical devices should be used to reduce manual handling of materials; team lifting should be utilized if mechanical devices are not available.
	6. Splashing	1. Wear safety goggles when collecting and handling decontamination water.
	7. Temperature Extremes	1. Drink plenty of fluids; train personnel of signs/symptoms of heat/cold stress; monitor air temperatures when extreme weather conditions are present; stay in visual and verbal contact with your buddy.
	8. Inclement Weather	1. Monitor weather conditions daily.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle	Location: Seattle, Washington
Activity: SAMPLE PROCESSING	Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
1. Removing core sample from core tubes	1. Back Injuries from heavy lifting	1. Site personnel will be instructed on proper lifting techniques; mechanical devices should be used to reduce manual handling of materials; team lifting should be utilized if mechanical devices are not available.
2. Logging and preparing core samples for laboratory analysis.	1. Contact with contaminated sediment	1. Wear modified Level D PPE. Undergo PPE decontamination. Establish work zones.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: BARGE MOUNTED DRILLING — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
1. Drilling operations - Inspection of Drill Rig	1. Improper inspection of rig could cause workers to be exposed to hazards associated with operating and mechanical device.	1. The rig and all associate equipment will be inspected by a competent mechanic and be certified to be in safe operating condition. 2. Equipment will be inspected before use and the beginning of each shift. 3. Faulty or unsafe equipment will be tagged and removed from service. No faulty equipment or damaged items will be allowed in the work area. 4. Verify the emergency shutdown system that consists of trip wire located at the right and left rear of the drill (located on each side – one for the driller and one for the driller's helper). Ensure that each wire shuts down the system when the trip wire is pulled or pushed. 5. Inspect the brakes and tire pressure on the drill rig. 6. Inspect all cables on the rig. 7. Inspect all hydraulic and pneumatic hoses.
2. Drilling operations – Set up work area and move rig into position	Failure to review site layout plan could cause exposure to potential hazards such as electrocution, damaging of underground utilities, tip over of rig in unstable soil conditions.	1. The site layout plan will become part of this hazard analysis as soon as it is completed. 2. The drilling rig will not be moved into any work area until the site layout plan has been completed and the route of travel to any work site has been assessed for hazards (overhead lines, stability of roads and ground). 3. The site layout plan and the analysis of the route of travel will be covered at the pre-activity safety briefing along with this activity hazard analysis.
	2. Damage to existing utilities.	1. Personnel will contact service facilities engineer before working near utilities. Site access to be provided by client.
	3. Vehicle may move if not properly set up.	1. Use spotter to properly position vehicle on barge. 2. Set brakes and place wheel chocks under front wheels of mobile rig. 3. Extend stabilizer jacks and ensure that footing is sound. 4. Vehicle must be level on the deck of the barge.
	4. When raising rig, rig may not install properly due to the condition of rig and connecting cables.	1. Inspect all components of rig to determine condition. 2. Make all repairs before raising rig.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle | Location: Seattle, Washington
Activity: BARGE MOUNTED DRILLING | Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
2. Drilling operations – Set up work area and move rig into position (continued)	5. When raising rig, mast could come in contact with or close proximity to overhead power lines causing electrocution of workers.	1. Mast and other equipment must be at least 15 feet from any overhead utility lines. 2. Verify the voltage of any overhead power lines. If any lines are above 50kV, the clearance distance must be greater. Refer to the US Army Corps of Engineer Safety and Health Requirements Manual EM 385-1-1, Section 11, Table 11-3 for clearance required for voltages above 50kV.
	6. Worker may become pinned between rig and other truck components or worker could be pinned under truck rig if servicing of rig from under the truck is required.	1. When any part of the rig or equipment is in motion, workers will stand a sufficient distance from the moving parts so that the worker is not pinned between the moving parts. 2. Workers will not manually “guide” any moving part of the rig when it is raised up. 3. Workers will not work under the rig or the truck. If work must be done under the truck or rig, the drill crew supervisor will contact the SSHO to ascertain a safe method for lockout of the equipment to ensure that adequate blocking is installed.
	7. High winds could destabilize rig. Mast could act as a conductor during a thunderstorm.	1. Check weather conditions and forecasts to determine if conditions are acceptable for use of rig. 2. Do not operate the rig if winds exceed manufacturer’s recommended tolerances. 3. Never raise a mast in an area where lightning is within 3 miles of rig.
	8. Noise.	1. Earplugs will be worn whenever drill rig is in operation.
	9. Pinch points.	1. Avoid placing hands in places close to moving machinery. 2. Wear gloves, as appropriate.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle	Location: Seattle, Washington
Activity: BARGE MOUNTED DRILLING	Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
3. Drilling operations- start up drill and perform drilling	1. Pressurized hydraulic lines could rupture causing release of hot hydraulic fluid. Hot fluid can ignite if contact is made with engine. Hot fluid can burn workers. Fluid can cause environmental contamination.	1. Personnel will have been trained in the use of drilling equipment. 2. Inspect all hydraulic lines before placing rig in service. Any damaged hoses or connections must be replaced before unit is used. 3. Immediately shut down the equipment. 4. Ensure that first aid kit is readily available to treat injured workers.. 5. A spill control kit consisting of shovel, absorbent material and disposal drum must be available at the drilling location. 6. As quickly as possible, berm the liquid to minimize the area over which the liquid spreads. Use absorbents on water surface after berm/containment if spill spreads to water. 7. If an oil spill causes a sheen on the water, report the spill to the National Response Center at 800-424-8802. (Hydraulic fluid may be oil or water based.) 8. Loose protective clothing will be restrained with duct tape to prevent entanglement in moving parts. 9. Hands will not be put in areas where parts are moving except as required for drill operation. 10. Drill rig will be moved with the boom down.
	2. Air hoses or hydraulic hoses under pressure could suddenly release, whip and hit workers causing severe injury.	1. Do not disconnect air hoses and compressors until hose line has been bled. 2. Visually inspect all connection of any lines under pressure. Use safety clamps to connect each side of connection to the other in the event the connection breaks. (the safety clamps will keep the hoses from whipping under the sudden release of pressure) 3. Tie back or attach hoses wherever possible to minimize the length of hose that could whip around in the event that there is a sudden release of pressure.
	3. Strains from manually moving materials, equipment, and drums.	1. Personnel will be directed to use proper lifting techniques such as keeping back straight, lifting with legs, limiting twisting, and getting help in moving bulky/heavy materials and equipment. 2. Mechanical equipment will be used as much as possible. 3. Use care when handling augers or drill rods. 4. Avoid standing under any load. 5. Get help for lifting any item that weighs 50-pounds or more.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: BARGE MOUNTED DRILLING — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
3. Drilling operations- start up drill and perform drilling (continued)	4. The mast could be used to lift other objects as it is being raised causing potential failure of the mast.	1. Masts shall be used in a manner specified by the manufacturer and should never be loaded beyond their capacity.
	5. Workers could climb drill mast and expose themselves to a fall hazard.	1. Climbing on the mast is not allowed.
	6. Workers could place hands into moving parts of the rig or loose clothing could become entangled in moving machine parts either of which could injure a worker.	1. Chains, sprockets and moving parts will be guarded. 2. Workers will not wear loose clothing, or any jewelry. 3. Workers will not place their hands or any part of their body between the drill auger or rod and the drill plate. Workers should never place themselves in a position where they can come in contact with the moving drill rods or augers. 4. The operator will verbally alert all workers and visually ensure that all workers are clear from dangerous parts of equipment before starting or engaging equipment. 5. Workers will avoid contact with any moving auger. Means will be provided to guard against employee contact with auger. (For example, use barricade of perimeter of auger or electronic brake activated by a presence-sensing device.)
	7. Workers could injure themselves by cleaning the augers while they are rotating.	1. Augers will be cleaned only when they are stopped and in neutral. They will not be restarted until the worker has given a verbal all clear to the operator and the operator has visually determined that the worker is clear of the auger. 2. Only long handled shovels will be used to move cutting from the auger.
	8. Workers could trip or fall while working on the vessel and fall into water.	1. All personnel on the vessel will wear Coast Guard approved PFDs 2. The moon hole on the vessel will be clearly identified and not left uncovered when not drilling.
	9. Pinch points.	1. Avoid placing hands in places close to moving machinery. 2. Wear gloves, as appropriate. 3. Keep constantly alert.
4. Removing core sample from core tubes	1. Back Injuries from heavy lifting	1. Site personnel will be instructed on proper lifting techniques; mechanical devices should be used to reduce manual handling of materials; team lifting should be utilized if mechanical devices are not available.
	2. Contact with contaminated sediments	1. Wear modified Level D PPE. Undergo PPE decontamination. Establish work zones.
5. Logging and preparing core samples for laboratory analysis.	1. Contact with contaminated sediment	1. Wear modified Level D PPE. Undergo PPE decontamination. Establish work zones.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: UPLAND SOIL SAMPLE COLLECTION WITH DRILL RIG — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
1. Drilling operations - Inspection of Drill Rig	1. Improper inspection of rig could cause workers to be exposed to hazards associated with operating and mechanical device.	1. The rig and all associate equipment will be inspected by a competent mechanic and be certified to be in safe operating condition. 2. Equipment will be inspected before use and the beginning of each shift. 3. Faulty or unsafe equipment will be tagged and removed from service. No faulty equipment or damaged items will be allowed in the work area. 4. Verify the emergency shutdown system that consists of trip wire located at the right and left rear of the drill (located on each side – one for the driller and one for the driller's helper). Ensure that each wire shuts down the system when the trip wire is pulled or pushed. 5. Inspect the brakes and tire pressure on the drill rig. 6. Inspect all cables on the rig. 7. Inspect all hydraulic and pneumatic hoses.
2. Drilling operations – Set up work area and move rig into position	1. Failure to review site layout plan could cause exposure to potential hazards such as electrocution, damaging of underground utilities, tip over of rig in unstable soil conditions.	1. The site layout plan will become part of this hazard analysis as soon as it is completed. 2. The drilling rig will not be moved into any work area until the site layout plan has been completed and the route of travel to any work site has been assessed for hazards (overhead lines, stability of roads and ground). 3. The site layout plan and the analysis of the route of travel will be covered at the pre-activity safety briefing along with this activity hazard analysis.
	2. Damage to existing utilities.	1. Personnel will contact service facilities engineer and/or utility locate before working near utilities. 2. Site access to be provided by client 3. Make sure weight of rig on ground is evenly distributed and is not so heavy as to damage any underground lines that may be near the surface.
	3. Vehicle may move if not properly set up.	1. Use spotter to properly position vehicle. 2. Set brakes and place wheel chocks under front wheels of mobile rig. 3. Extend stabilizer jacks and ensure that footing is sound. 4. Vehicle must be level to the vertical and horizontal planes.
	4. When raising rig, rig may not install properly due to the condition of rig and connecting cables.	1. Inspect all components of rig to determine condition. 2. Make all repairs before raising rig.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: UPLAND SOIL SAMPLE COLLECTION WITH DRILL RIG — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
Drilling operations – Set up work area and move rig into position (continued)	5. When raising rig, mast could come in contact with or close proximity to overhead power lines causing electrocution of workers.	1. Mast and other equipment must be at least 15 feet from any overhead utility lines. 2. Verify the voltage of any overhead power lines. If any lines are above 50kV, the clearance distance must be greater. Refer to the US Army Corps of Engineer Safety and Health Requirements Manual EM 385-1-1, Section 11, Table 11-3 for clearance required for voltages above 50kV.
	6. Worker may become pinned between rig and other truck components or worker could be pinned under truck rig if servicing of rig from under the truck is required.	1. When any part of the rig or equipment is in motion, workers will stand a sufficient distance from the moving parts so that the worker is not pinned between the moving parts. 2. Workers will not manually “guide” any moving part of the rig when it is raised up. 3. Workers will not work under the rig or the truck. If work must be done under the truck or rig, the drill crew supervisor will contact the SSHO to ascertain a safe method for lockout of the equipment to ensure that adequate blocking is installed.
	7. High winds could destabilize rig. Mast could act as a conductor during a thunderstorm.	1. Check weather conditions and forecasts to determine if conditions are acceptable for use of rig. 2. Do not operate the rig if winds exceed manufacturer’s recommended tolerances. 3. Never raise a mast in an area where lightning is within 3 miles of rig.
	8. Noise.	1. Earplugs will be worn whenever drill rig is in operation.
	9. Pinch points.	1. Avoid placing hands in places close to moving machinery. 2. Wear gloves, as appropriate.
3. Drilling operations- start up drill and perform drilling	1. Pressurized hydraulic lines could rupture causing release of hot hydraulic fluid. Hot fluid can ignite if contact is made with engine. Hot fluid can burn workers. Fluid can cause environmental contamination.	1. Personnel will have been trained in the use of drilling equipment. 2. Inspect all hydraulic lines before placing rig in service. Any damaged hoses or connections must be replaced before unit is used. 3. Immediately shut down the equipment. 4. Ensure that first aid kit is readily available to treat injured workers.. 5. A spill control kit consisting of shovel, absorbent material and disposal drum must be available at the drilling location. 6. As quickly as possible, berm the liquid to minimize the area over which the liquid spreads. 7. Loose protective clothing will be restrained with duct tape to prevent entanglement in moving parts. 8. Hands will not be put in areas where parts are moving except as required for drill operation. 9. Drill rig will be moved with the boom down.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle — Location: Seattle, Washington

Activity: UPLAND SOIL SAMPLE COLLECTION WITH DRILL RIG — Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
Drilling operations- start up drill and perform drilling (continued)	2. Air hoses or hydraulic hoses under pressure could suddenly release, whip and hit workers causing severe injury.	1. Do not disconnect air hoses and compressors until hose line has been bled. 2. Visually inspect all connection of any lines under pressure. Use safety clamps to connect each side of connection to the other in the event the connection breaks. (the safety clamps will keep the hoses from whipping under the sudden release of pressure) 3. Tie back or attach hoses wherever possible to minimize the length of hose that could whip around in the event that there is a sudden release of pressure.
	3. Strains from manually moving materials, equipment, and drums.	1. Personnel will be directed to use proper lifting techniques such as keeping back straight, lifting with legs, limiting twisting, and getting help in moving bulky/heavy materials and equipment. 2. Mechanical equipment will be used as much as possible. 3. Use care when handling augers or drill rods. 4. Avoid standing under any load. 5. Get help for lifting any item that weighs 50-pounds or more.
	4. The mast could be used to lift other objects as it is being raised causing potential failure of the mast.	1. Masts shall be used in a manner specified by the manufacturer and should never be loaded beyond their capacity.
	5. Workers could climb drill mast and expose themselves to a fall hazard.	1. Climbing on the mast is not allowed.
	6. Workers could place hands into moving parts of the rig or loose clothing could become entangled in moving machine parts either of which could injure a worker.	1. Chains, sprockets and moving parts will be guarded. 2. Workers will not wear loose clothing, or any jewelry. 3. Workers will not place their hands or any part of their body between the drill auger or rod and the drill plate. Workers should never place themselves in a position where they can come in contact with the moving drill rods or augers. 4. The operator will verbally alert all workers and visually ensure that all workers are clear from dangerous parts of equipment before starting or engaging equipment. 5. Workers will avoid contact with any moving auger. Means will be provided to guard against employee contact with auger. (For example, use barricade of perimeter of auger or electronic brake activated by a presence-sensing device.)
	7. Workers could injure themselves by cleaning the augers while they are rotating.	1. Augers will be cleaned only when they are stopped and in neutral. They will not be restarted until the worker has given a verbal all clear to the operator and the operator has visually determined that the worker is clear of the auger. 2. Only long handled shovels will be used to move cutting from the auger.

ACTIVITY HAZARD ANALYSIS

Project: Lockheed West Seattle	Location: Seattle, Washington
Activity: UPLAND SOIL SAMPLE COLLECTION WITH DRILL RIG	Analysis approved by: T. Froelich

MAJOR STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES/CONTROLS
Drilling operations- start up drill and perform drilling (continued)	8. Workers could trip or fall while working on the vessel.	1. All personnel on the vessel will wear Coast Guard approved PFDs 2. The moon hole on the vessel will be clearly identified and not left uncovered when not drilling.
	9. Pinch points.	1. Avoid placing hands in places close to moving machinery. 2. Wear gloves, as appropriate. 3. Keep constantly alert.
5. Logging and preparing soil samples for laboratory analysis.	1. Contact with contaminated soil.	1. Wear modified Level D PPE. Undergo PPE decontamination. Establish work zones.

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ATTACHMENT D

Tetra Tech Work Rules

Tetra Tech
GENERAL HEALTH AND SAFETY RULES

1. All site personnel must attend each day's Daily Briefing.
2. Any individual taking prescribed drugs shall inform the FSL/SSHO of the type of medication. The FSL/SSHO will review the matter with the PESM and the Corporate Medical Consultant (CMC), who will decide if the employee can safely work on-site while taking the medication.
3. All site personnel shall wear the personal protective equipment specified by the FSL/SSHO and in the EHS Plan(s). This includes hard hats and safety glasses that must be worn at all times in active work areas.
4. Facial hair (beards, long sideburns or mustaches) which may interfere with a satisfactory fit of a respirator mask is not allowed on any person who may be required to wear a respirator.
5. All personnel must sign the site log and the exclusion zone log when used at the site.
6. Personnel must follow proper decontamination procedures
7. Eating, drinking, chewing tobacco or gum, smoking and any other practice that may increase the possibility of hand-to-mouth contact is prohibited in the exclusion zone or the contamination reduction zone. (Exceptions may be permitted by the PESM to allow fluid intake during heat stress conditions.)
8. All lighters, matches, cigarettes and other forms of tobacco are prohibited in the Exclusion Zone.
9. All signs and demarcations shall be followed. Such signs and demarcation shall not be removed, except as authorized by the FSL/SSHO.
10. No one shall enter a permit-required confined space without a permit. Confined space entry permits shall be implemented as issued.
11. All personnel must follow Hot Work Permits as issued.
12. All personnel must use the Buddy System in the Exclusion Zone.
13. All personnel must follow the work-rest regimens and other practices required by the heat stress program.
14. All personnel must follow lockout/tagout procedures when working on equipment involving moving parts or hazardous energy sources.
15. No person shall operate equipment unless trained and authorized.

16. No one may enter an excavation greater than four feet deep unless authorized by the Competent Person. Excavations must be sloped or shored properly. Safe means of access and egress from excavations must be maintained.
17. Ladders and scaffolds shall be solidly constructed, in good working condition, and inspected prior to use. No one may use defective ladders or scaffolds.
18. Fall protection or fall arrest systems must be in place when working at elevations greater than six feet for temporary working surfaces and four feet for fixed platforms.
19. The Supervisor must select safety belts, harnesses and lanyards. The user must inspect the equipment prior to use. No defective personal fall-protection equipment shall be used. Personal fall protection that has been shock loaded must be discarded.
20. Hand and portable power tools must be inspected prior to use. Defective tools and equipment shall not be used.
21. Ground fault interrupters shall be used for cord and plug equipment used outdoors or in damp locations. Electrical cords shall be kept out walkways and puddles unless protected and rated for the service.
22. Improper use, mishandling, or tampering with health and safety equipment and samples is prohibited.
23. Horseplay of any kind is prohibited.
24. Possession or use of alcoholic beverages, controlled substances, or firearms on any site is forbidden.
25. All incidents, no matter how minor, must be reported immediately to the Supervisor.
26. All personnel shall be familiar with the Site Emergency Response Plan.
27. Cell phones will only be used in the EZ unless the phone can be decontaminated.

The above Health and Safety Rules are not all inclusive and it is your responsibility to comply with all regulations set forth by OSHA, Tetra Tech's Health and Safety Programs, the EHS Plan(s), the client, Tetra Techs Supervisors, and the FSL/SSHO.

ATTACHMENT E

Field Forms

(b)(4) copyright

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ATTACHMENT F

Hospital Route Maps and Location Maps

Directions from Jack Block Shoreline Access to Virginia Mason Hospital

Start:

2130 Harbor Ave Sw
Seattle, WA 98126-2033, US

End:

Virginia Mason Hospital: 206-583-6433

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(b)(4) copyright

Directions from Jack Block Shoreline Access to Harborview Hospital

Start:

2130 Harbor Ave SW
Seattle, WA 98126-2033, US

End:

Harborview Medical Center: 206-744-3000
325 9th Ave, Seattle, WA 98104

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(b)(4) copyright